POWER PLANT ENGINEERING

Trade-mark reg. U. S. Pat. Office

VOL. XXIV CHICAGO, SEPTEMBER 15, 1920 No. 18

Where Electricity is a By-Product

EXHAUST STEAM FROM LARGE NUMBER OF STEAM HAMMERS IS USED TO GENERATE ELECTRICITY AND HEAT FEED WATER FOR ENTIRE PLANT

ON THE OUTSKIRTS of Chicago, in that busy manufacturing district known as West Pullman, there rises above the surrounding factory buildings a tall white chimney, conspicuous because of its height and pleasing to the eye because of its graceful lines. This chimney, which towers over 225 ft. high, is a part of the new power plant recently built and put into operation by J. H. Williams & Co., now consolidated with the Whitman & Barnes Mfg. Co., one of the largest manufacturing plants devoted exclusively to the production of drop forgings in this country.

But though this stack is conspicuous on account of its correct design, to the individual having the opportunity of visiting this power plant, it will, at once, be perfectly apparent that the design of the stack is merely in accordance with the design of the plant as a whole. Correct design combined with perfect simplicity is one of its outstanding features. Throughout the buildings a plentiful supply of floor space was provided, thus allowing for ample freedom in the arrangement of ma-

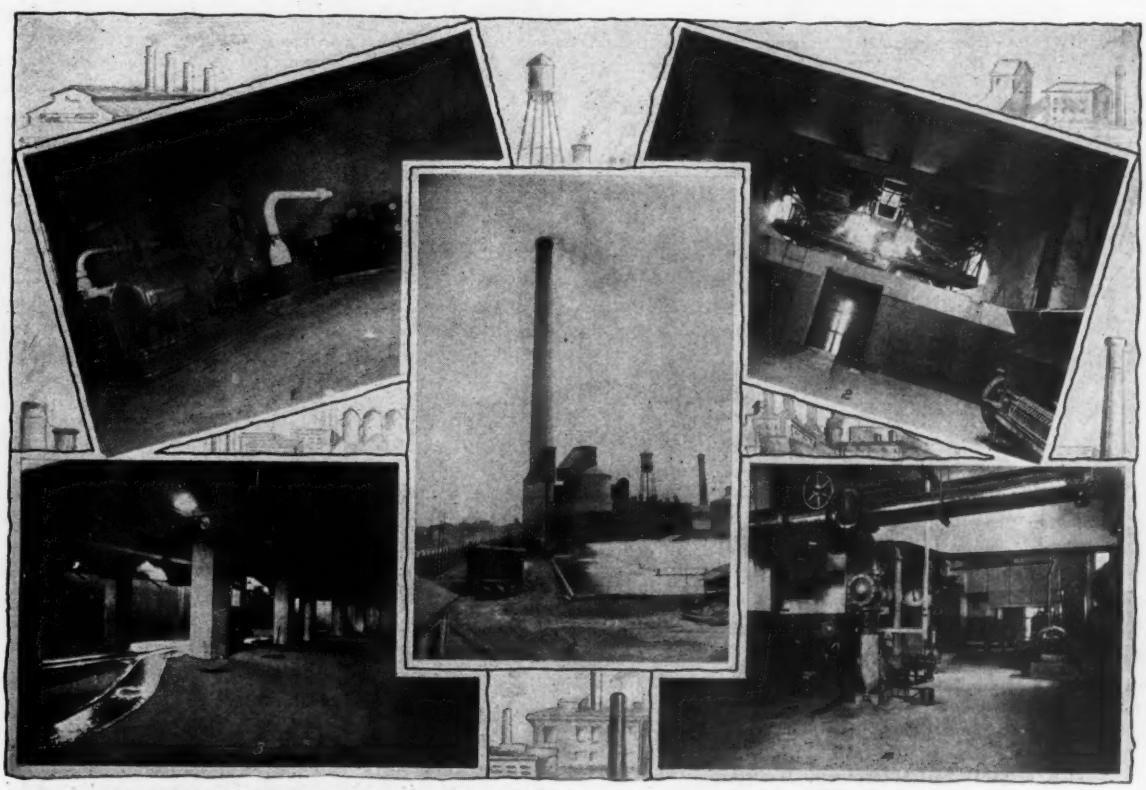


FIG. 1. ONE OF THE TWO UNITS. FIG. 2. ELECTRIC WEIGHING LARRY IN POSITION TO RECEIVE COAL FROM BUNKERS. FIG. 3. BASEMENT OF BOILER ROOM SHOWING ASH DISCHARGE HOPPERS FROM FURNACES. FIG. 4. BASEMENT OF TURBINE ROOM SHOWING CONDENSING EQUIPMENT AND AIR WASHER. FIG. 5. OUTSIDE VIEW OF PLANT AND COOLING POND.

chinery. Large windows which can be opened and closed from the inside admit an abundance of daylight and air which seems to permeate into every nook and corner.

This plant which has a nominal boiler capacity of 3000 hp. furnishes all the power, light, and heat necessary for manufacturing purposes to the factory buildings. The power is available either as steam, as electricity, or in the form of compressed air.

Electric Power a By-Product

In describing the plant, perhaps the most interesting feature is in the method of operating the main turbo-generators which provide the electrical energy. These machines are of the mixed pressure type, designed to operate at either 115 lb. absolute or at 17.5 lb. absolute steam pressure. Under all normal operating conditions these machines run on a steam pressure of about 3 lb. per sq. in. gage.

The reason for operating the main units at this low pressure may be explained briefly as follows: The nature of the product manufactured by J. H. Williams & Co. makes it necessary to operate a large number of steam hammers throughout the works. These hammers take steam from the boilers through a reducing valve at 100 lb. gage pressure and exhaust into a common system. This exhaust is then led from the shops through a tunnel into the basement of the power house where it discharges into a large receiver. From the receiver the steam is delivered part to the turbines, part to the feed water heater and all in excess of the amount required

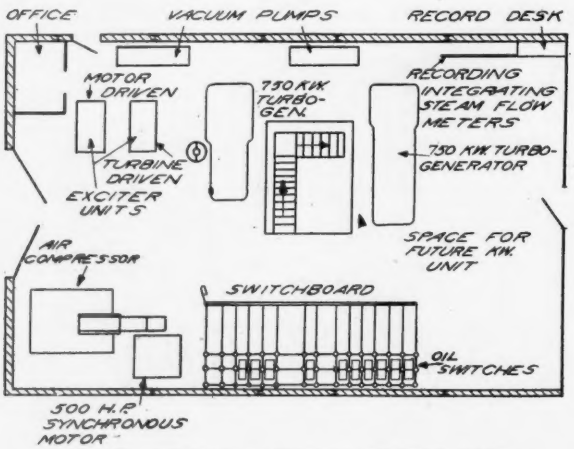


FIG. 6. GENERAL LAYOUT OF TURBINE ROOM

for these two purposes is exhausted to the atmosphere. There being an excess of exhaust steam at all times it is never necessary to operate the turbines at high pressure. The electric energy, therefore, is more in the nature of a by-product and as a consequence practically all of the station auxiliaries are motor driven; steam being used only in cases of emergency. Before describing the turbine room in detail, however, we will start at the beginning, where the coal comes into the plant.

Coal and Ash-Handling Machinery

Coal is delivered from railroad cars into a hopper underneath the track onto a belt conveyor which carries it to a 50-ton crusher. The coal burned is generally Illinois screenings and everything below No. 4 is sent through the crusher so as to reduce it to a suitable size for use in the furnaces. From the crusher it is delivered to a bucket conveyor which elevates it and discharges it into the 500-ton cylindrical concrete coal bunker located above and at one end of the boiler house, as shown in Fig. 11. The crusher and conveyors, as well as all of the ash-handling machinery to be described later, are operated by electric motors, automatically controlled by push buttons.

Figure 3 is a view in the basement underneath the

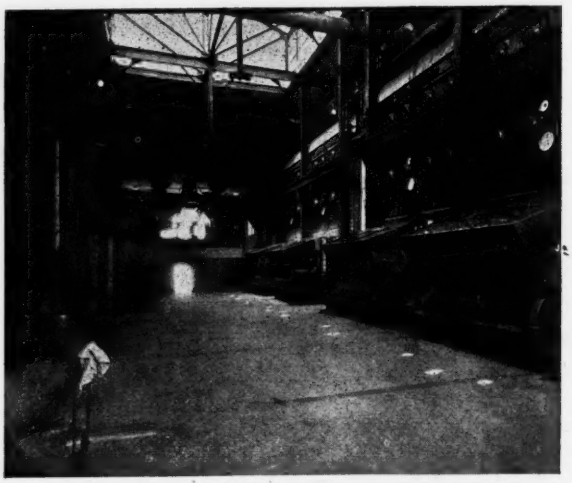


FIG. 7. BOILER ROOM, SHOWING WEIGHING LARRY AT THE END OF ITS TRAVEL

boiler room. Ashes from the furnaces fall into concrete hoppers which are fitted with valves, thereby enabling the men to discharge the refuse, by gravity, directly into push-cars which operate over a narrow gage railroad. These cars deliver the ashes through an underground system to the base of the ash receiving hopper, shown in Fig. 11. The contents of a car having been dumped into the wedge-shaped bucket attached to the elevator, the attendant presses a button, which sets the elevator in motion and the ashes are discharged into the top of the concrete hopper. From here it is fed by gravity into railroad cars or trucks as the case may be. The machinery, but for the pressing of the button, is entirely automatic in operation, and once having been started the attendant may return to the furnaces for another load.

The screenings from the chain grate stokers are also recovered in separate hoppers underneath the boiler room. These are also discharged into the push cars in the same manner as the ashes but are wheeled to the coal conveyor which delivers the recovered fuel back into the coal bunker.

The Boiler Room

At present, the steam generating equipment comprises six 500-hp. water tube boilers equipped with chain grate stokers. As will be seen in the accompanying photographs, the boiler room is so arranged that ultimately there will be four boilers on each side of the room, space having been provided for two future units.

Steam is generated ordinarily at a pressure of 150

lb. and is then passed through a reducing valve where it is reduced to 100 lb. for use in the steam hammers previously referred to. This assures an absolutely uniform pressure at the steam hammers regardless of any fluctuations at the boilers.

The chain grate stokers are driven from line shafts on the basement ceiling. These line shafts, of which there are two, one for each line of boilers, are operated by the two vertical engines shown in Fig. 8. Forced draft is not employed, sufficient natural draft being provided by the tall stack. This stack is built of Custodis radial brick, is 229 ft. in height and has an average diameter of 11 ft. Each boiler is equipped with a steam-flow meter mounted directly above the pressure gage; an accurate indication as to the distribution of the load among the boilers is thus assured at all times.

Six recording and integrating steam-flow meters mounted on a panel in the turbine room furnish a permanent record of the total amount of steam generated each week, together with a record of the variations in load. These records when compared with the data regarding the number of pounds of coal burned reduce evaporation calculations to a minimum.

Coal is delivered from the bunker by gravity to the electric weighing larry. This larry is fitted with a beam scale of the printing type and as each charge of fuel is distributed to the various stokers a record of the amount is automatically preserved. As shown in Figs. 2 and 7, the larry is in a position to receive coal from the bunkers.

The entire absence of coal bunkers or other apparatus above the boiler room aisle has made possible the construction of a large skylight, thereby dispensing with all artificial illumination during the daytime. At night illumination is provided by high powered lamps suspended from the steelwork, and provided with enameled steel reflectors.

A 3500-hp. feed-water heater located on a platform at the end of the boiler room furnishes an ample supply of water for the boilers. Multi-stage centrifugal boiler feed pumps deliver the water into the boilers. As stated before, the feed heater is furnished with exhaust steam from the steam hammers throughout the factory. The

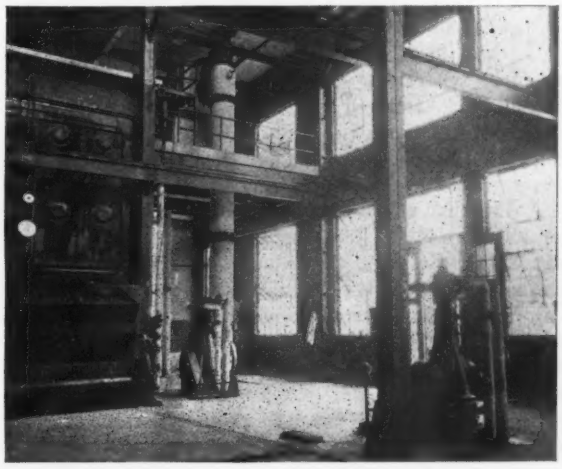


FIG. 8. VIEW IN BOILER ROOM, SHOWING FEED-WATER HEATER AND STOKER ENGINES

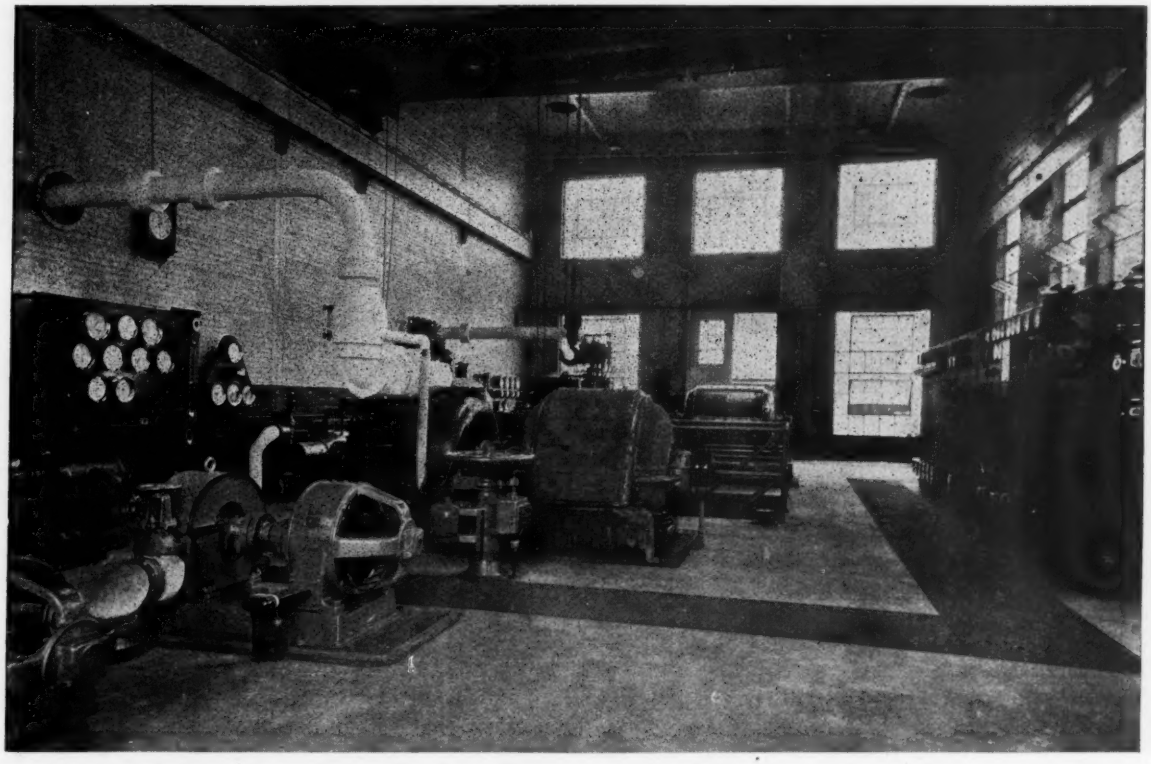


FIG. 9. GENERAL VIEW OF TURBINE ROOM

large exhaust line may be seen coming up through the floor by referring to Fig. 8.

The Turbine Room

The turbine room, a roomy place with south, east and west exposure, presents a cheerful appearance. The large windows eliminate dark corners where dust and dirt can accumulate—all machinery is conveniently located and affords ready accessibility. The two 750-kw. turbo-generators occupy a central position in the room and are arranged to exhaust directly into the condensers in the basement below. Gage boards mounted against the wall close to the turbines contain the necessary instruments for determining pressures and vacuum.

A 15-panel switchboard controls the output of the two 750-kw., 440-v., 60-cycle generators. As shown in Fig. 10, the first six panels are feeder panels. These, together with the generators and regulator panels, are equipped with oil circuit breakers. Besides the house service panels, the exciter and synchronous motor panels, two panels have been left blank to serve as future generator panels. The voltage used throughout the factory and in the station is 440 and as this is the generated voltage, all need of transformers is eliminated.

While the station auxiliaries are for the most part motor driven, a number of the machines such as the exciter unit and boiler feed pumps are provided in duplicate, one being motor driven and the other turbine driven. This reduces the possibility of shut-down to a minimum.

The machine at the far end of the switchboard in Fig. 10 is a 500-hp. air compressor, furnishing compressed air for use in the factory. It is driven by a synchronous motor which helps to improve the power factor of the system.

A five-ton traveling crane is installed in the turbine room for the handling of machinery.

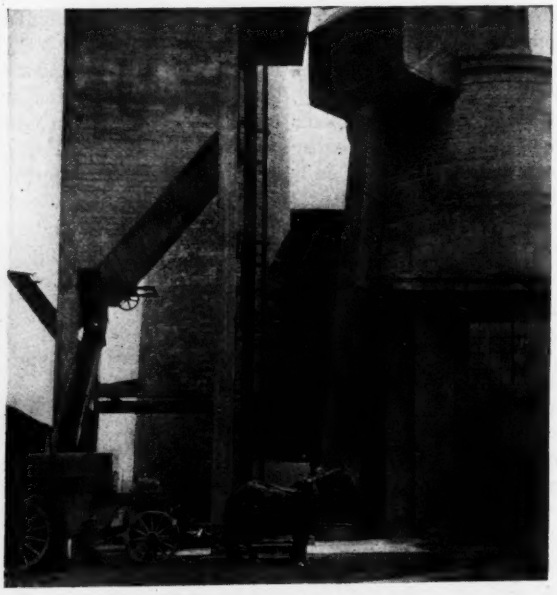


FIG. 11. COAL AND ASH-HANDLING APPARATUS

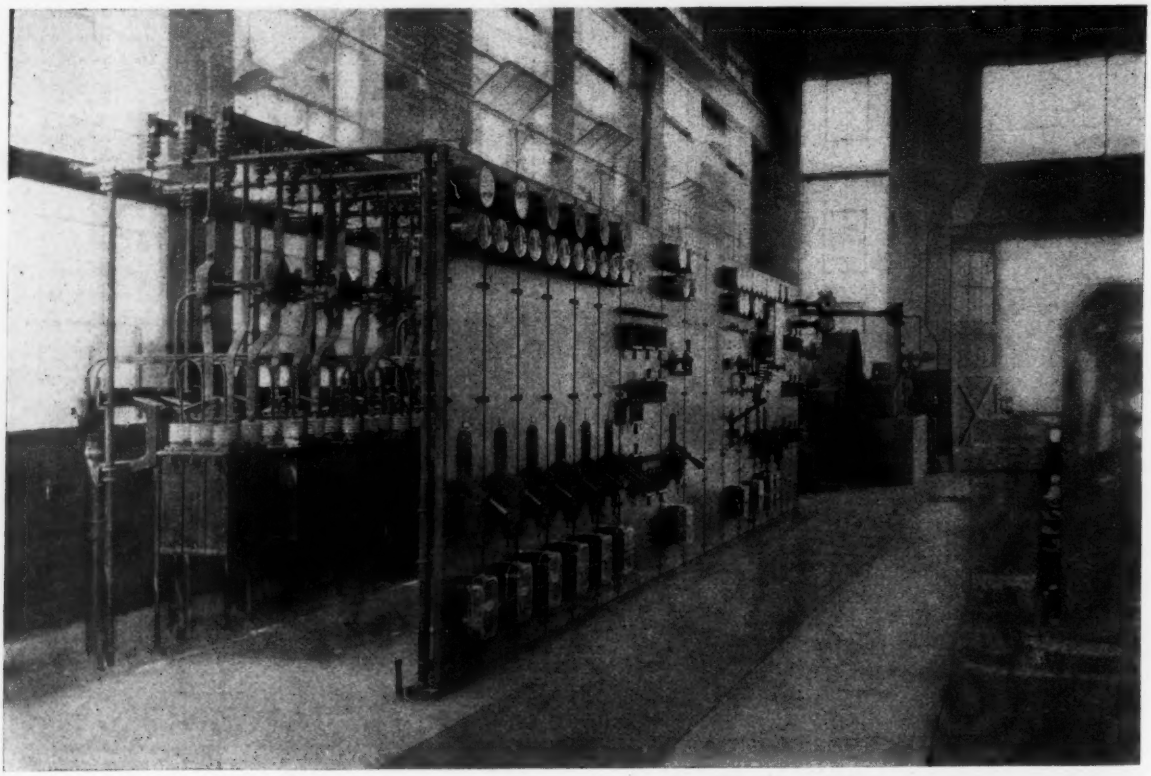


FIG. 10. SWITCHBOARD AND AIR COMPRESSOR

Condensing Equipment

The condensing equipment, with the exception of the two vacuum pumps, is located in the basement of the turbine room. Here, also, are the two centrifugal boiler feed pumps, the circulating pumps, the air cooling and washing apparatus for supplying the generator windings with a blast of cool, clean air, the low head service pumps, and the exhaust steam receiver.

Each condenser has a water rate of 3000 g.p.m. Water is drawn from the cooling pond by means of two motor-driven centrifugal circulating pumps. High vacuum is secured by two dry vacuum pumps of the rotative tandem center crank design. These, however, are located upon the floor above in the turbine room.

The cooling pond, shown in Fig. 5, is fitted with a spray cooler consisting of six branches, each branch having a capacity of 1000 g.m.p. This gives the total of 6000 g.p.m. necessary for supplying the condensers with circulating water.

This completes briefly a description of the plant as it is equipped at the present time. In the turbine room there is space for a future 1500-kw. generating unit and if necessary the east end of the building can easily be extended as the present wall of corrugated sheet iron is merely a temporary affair.

Lubrication and Lubricants*

Properties of Lubricants and Their Action Eliminating Solid Friction. By G. B. Upton

THERE ARE still to be seen, and heard, in various out-of-the-way corners of the earth's surface, wagons with solid wooden wheels working without grease on wooden axles. These primeval wagons may well indicate what was the first use of lubrication, a use many people still think of first when a lubricant is applied—it stops that noise.

Aside from aesthetic considerations for our ears, the noise means perhaps heavy and needless friction losses of power, and undoubtedly it means wear and tear of machinery, and repair bills to come.

The value of lubrication is first in the fact that it brings friction losses in machinery to tolerably small amounts. Second, by reducing abrasion of metal moving past metal almost to the vanishing point, lubrication not only makes machinery possible which otherwise would be impossible, but even makes the machinery long lived and free from repair expense.

The cost of lubrication should not be considered simply as the cost of the lubricant and its application. The lubricant should be credited with the power saved by reduction of friction, and the saving of wear of machinery, and avoidance of wage and production losses while machinery unlubricated, or less well lubricated, would be standing idle for repairs.

Before trying to study the laws of friction under lubricated conditions, it is well to review those of solid friction.

There are two principal factors in solid friction. One, usually a minor factor, is obviously abrasion, the actual tearing loose of projecting portions of material. Abrasion is worse with rough surfaces and high contact pressures. The major factor in solid friction comes from the rise and fall of the attractions of the molecules at the surface of one body for corresponding molecules at the surface of the other body as they go by each other, or perhaps from their actual mechanical bumping of each other without abrasion. Either action involves a conversion of mechanical energy of the moving body into vibrational energy of motion of the molecules of the two bodies; which energy, in other words, is heat energy in the bodies. This kind of friction of solids would exist even though abrasion were entirely absent, and constitutes far the largest part of solid friction in all practical cases.

When a lubricant is used, these laws of friction of solids go utterly into the discard. The coefficient of friction goes from a value of around 0.2, for solids, to anywhere from 0.001 to infinity, with complete fluid friction. We commonly get, in bearings, coefficients of friction from 0.005 to 0.02, under actual running conditions—values less than one-tenth those for unlubricated conditions. The value of infinity for coefficients of friction in a lubricated bearing is a freak, occurring in the case of zero load, which is coupled for fluid friction with a finite friction. This freak case is mentioned as a jolt to the common, and erroneous, statement that a coefficient of friction cannot exceed unity. The coefficient can and does exceed unity for very light loads with fluid lubrication; and when lubrication fails and bearings "seize," tearing and welding metal into metal, the coefficient of solid friction exceeds unity and approaches infinity.

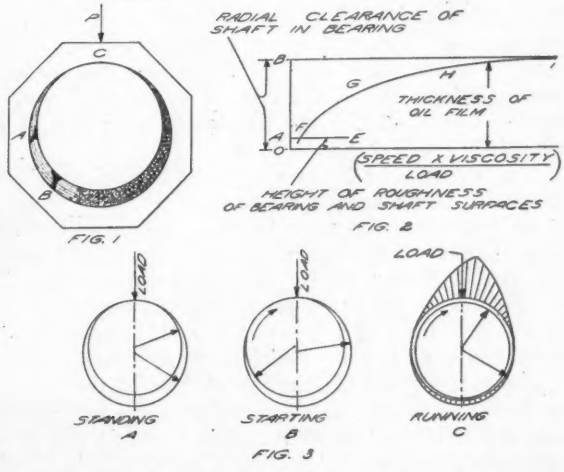


FIG. 1. OIL IN BEARING—SHOWING VELOCITY TRAVERSE CURVES

FIG. 2. DIAGRAM SHOWING RELATION OF OIL FILM THICKNESS TO FORCE RATIO

FIG. 3. SUCCESSIVE POSITIONS OF SHAFT IN STARTING

* Abstract from an article appearing in the Sibley Journal of Engineering which is the result of research carried on at Sibley College, Cornell University.

The laws of friction of an actual bearing may be anywhere between the laws of "perfect fluid friction" on one side, and plain solid friction on the other side, depending upon the load, the speed, and the properties of the lubricant. The most important single property of the lubricant is its "viscosity." Viscosity is a property of a lubricant that works both for us and against us, but on the whole is necessary to the success of lubrication.

Surface Tension

When a shaft is standing still in a bearing another property of an oil becomes important—the "surface tension" or "capillarity." The molecules of a substance have an attraction for one another, and also may feel attractions for molecules of other substances, if those others are near enough as molecules know distances. At the surface where a liquid touches a solid, the attractions of molecules of the liquid for the rest of the liquid, in one direction away from the contact surface, are in competition with the attractions in the other direction of the liquid molecules near the contact surface toward the mass of the solid. Usually the latter force is the stronger, and the liquid tends to climb and spread itself out on the surface of the solid, or "wets" the solid. The opposite case is possible, as witness the action of mercury; small portions of liquid mercury roll themselves up into little balls when lying on a surface of a solid, because mercury has a higher "surface tension" than almost any solid. The "wetness" of a liquid is the reciprocal function of the surface tension. Hot water is wetter than cold water, because the surface tension is less; and oils are much wetter than water, usually, for an oil film will displace a water film on a metal if it gets a chance to do so.

The wetness, or lowness of surface tension, of an oil gives it in a bearing a readiness to serve a lubricant. If we feed oil to the crack between bearing and shaft, when the shaft is stationary, the oil will promptly crawl into the crack and fill it. The thinner the crack the harder does the oil try to get in, and the farther will it crawl. The force of this action is not big enough, unfortunately, to lift the bearing off the shaft on the loaded side. The best that the wetness of the oil can do for us is to get the clearance space of the bearing loaded with oil, so that when motion starts oil will be in place ready to begin lubrication after a fraction of the first revolution of the shaft; not over a quarter turn is needed when circumstances are favorable.

Adsorption

Closely connected in nature with the phenomena of surface tension is another action, whose value in lubrication we are but just beginning to appreciate. If we study a solution of a salt in water, we find that the concentration of the salt at the surface of the water is not the same as it is inside the bulk of the solution. Few oils are unit, single substance chemically. They are solutions in each other of considerable numbers of substances. At the surface where the oil touches a solid, the composition will be a bit different from that of the bulk of the oil; or we may say that the properties of an oil surface, such as viscosity, will be different from the properties that we find for the oil as tested in bulk. The thinner the oil film in our bearings the more important will such differences be. The layer of oil affected by this type of action is only a few molecules thick. This phenomenon we will call "adsorption." It probably accounts in large part for the astoundingly large effects, for example, of the addition to a mineral oil of one or two per cent of a fatty acid, as in the recent experimental work of H. M. Wells and J. E. Southcombe; and in large degree is the explanation of the different "body" or "oiliness" of different oils of approximately the same viscosities.

We are quite familiar with the fact that the viscosities of oils change rapidly as temperature changes. Too frequently we neglect the fact that viscosity is also a function of pressure. At low pressures (a few hundreds of pounds per square inch) this effect of pressure on viscosity is fairly negligible. For pressures of thousands of pounds per square inch, the effect of pressure on viscosity becomes important, and the increase of viscosity is with something like the square of the pressure. Pressures in an oil film between bearing and shaft, under high loads and low speeds, quite often run up to the region where the effect of pressure upon viscosity (increasing it) is appreciable. This action combines with the adsorption phenomena and together the two actions probably constitute "body," or "oiliness" of the lubricant as far as that property may be distinguished from the viscosity which is measured at ordinary pressures. The distinction between "viscosity" and "body" is at times large.

Action of Lubricant in Bearing

The viscosity of a lubricant is the property principally concerned in the formation and maintenance of the lubricating film under ordinary running conditions of machinery. When a shaft is stationary in a bearing the oil usually coats the surface of the shaft more or less completely, save on the side toward the load on the bearing. In that direction, the load has squeezed the oil out, and metallic contact exists.

When the shaft begins to turn, it tries to carry oil with it. This first motion of the shaft must overcome solid friction, on the surface where oil has been squeezed out. As the rotation continues and speeds up, a contest begins. The shaft tries to carry oil up into the region where the load has been holding shaft and bearing in metallic contact. The bearing tries to wipe this oil off the shaft, and keep the lubricating film from forming. The force which the bearing brings to bear to keep the oil out is the load. The force by which the shaft tries to bring oil in depends on the speed of the shaft, the form, dimensions, and clearance of the bearing surface, and on the viscosity of the oil. To move one layer of oil over another requires a force proportional to the product of the speed of the motion and the viscosity of the oil. Figure 1 may show that in preventing the formation of the oil film the bearing would have to overcome this viscous force, proportional to the product of speed of shaft and viscosity of oil. It depicts the oil layers trying to move up with the motion of the shaft, and being successfully held back by the bearing. Two approximate velocity traverse curves through the oil film are shown at A and B.

At some critical value of the speed, as speed increases,

the viscous force tending to form the oil film overcomes the load on the bearing, and the oil goes through, lifting the bearing on an oil film, and ending metallic contact and metallic friction. With further increase of speed above this critical speed, where solid friction ends and fluid friction begins, the oil film grows thicker. This thickening of the oil film does not, and cannot, go on indefinitely as the speed increases. The limit of film thickness is set by the radial clearance of bearing and shaft, or by concentric running of the shaft in the bearing. The higher the speed of the shaft and the viscosity of the oil, the nearer will the thickness of the oil film approach the radial clearance as a limit. The thickness of the oil film, at which a bearing runs, depends on the ratio of the forces trying to form and to break the film, or it depends on the ratio of load to the product of speed and viscosity. Figure 2 shows the form of the relation between thickness of oil film and the force ratio, using the force ratio in the reciprocal form from the preceding statement.

There is another action which in starting a shaft supplements the viscous force in getting the oil film through and ending solid friction. Incidentally, this second action may be present during starting, and absent during stopping, so that a bearing perhaps forms an oil film, in starting, at a lower value of speed times viscosity divided by load, than that marking seizure in stopping. This second action is illustrated in Fig. 3, A and B. Before motion starts, bearing and shaft will be in the relations to each other shown in A. When the shaft starts to rotate, it will shift its contact point with the bearing, as in B, back against the direction of rotation. But this shift or attempt at it promptly pinches between shaft and bearing, at the new contact point, the oil film which was already present there. Only about 15 deg. of shaft rotation is needed to bring this action into play. (Tangent 15 deg. = 0.27, which is greater than the usual coefficient of solid friction.) If, before the end of this first 15 deg. of motion, the acceleration has been high enough to get the speed above the minimum necessary to maintain the oil film, it is actually possible to get the shaft under way without experiencing any solid friction of the slipping, or abrasive, type. In that case, the starting friction will be fairly low. If the acceleration in starting is small, so that after 15 deg. of rotation the shaft velocity is still below the minimum necessary to maintain the film, then the shaft rolls for the first 15 deg. and then slips with solid friction until the speed goes high enough to carry the oil through. This latter is the usual case for plain bearings, certainly so when they start under heavy loads; and this high starting friction under load constitutes one of the disadvantages of a plain bearing when it is compared with ball or roller bearings.

When a machine has been standing idle for a time the oil in it has cooled off to about the temperature of its surroundings, and with the cooling the viscosity has become high. This high viscosity helps starting, at least in the sense that the oil film will be formed in the bearings at a lower speed. It is the product of speed by viscosity which makes the force forming the oil film; the higher the viscosity the lower will the speed need to be. Someone who has hand-cranked an automobile engine outdoors in zero weather may doubt the statement above that a cold oil makes easier starting; but he should think again, and remember that it is the cold oil between pistons and cylinders that makes the engine stiff, not the cold oil in the bearings.

Danger of Seizing with Low Viscosities

As the cold machine comes up to speed, the function (speed times viscosity divided by load) runs up to high values, for the viscosity is still very high. The oil film then builds up to full thickness, as illustrated in the region HI, or beyond, in Fig. 2. This assumes, of course, an adequate supply of oil. Then the friction warms up the machine, as time goes on, and this lowers the viscosity of the oil. This lowering of viscosity results in a thinning of the oil film; the machine after warming up probably operates its bearings in the region CH of Fig. 2. If it gets into the region FG there is danger, with a slight further warming up, of breaking the oil film or having a bearing "seize."

The remedy for seizing, since load and speed are fixed in the design and operation of the machine, is obviously the change of oil to one of the higher viscosity. The low limit of tolerable viscosity for oil in a given machine is that viscosity which will give a fair factor of safety against seizing of the bearings when they are working at their worst combination of low speed and high load; and this viscosity must be had at the upper limit of bearing temperatures in the operation of the machine.

The low limit of tolerable viscosity, defined above, usually goes with about the lowest coefficient of friction of which the bearing is safely capable. Lower friction still might be had, for the lowest of all is just off the edge of seizing. As we prefer to keep away from seizing we accept a friction a bit higher than the minimum, for the sake of safety. The high limit of viscosity in oil for a given machine is usually set by the change of viscosity with temperature, the change of operating temperature, and the necessary minimum value of viscosity at the highest operating temperature. We just have to put up with what happens at the low end of the operating temperatures, for we can't help ourselves.

The action of a plain bearing when a machine is being shut down, and shaft speed comes down to zero, is in type very nearly the reverse of what happens in starting. The detail is different, mainly because the machine, and the oil in the bearings, are warmer than at starting. Viscosities are less, often considerably less, on account of the higher temperatures. The speeds at which the oil film breaks in shutting down are much higher than those at which the oil film forms in starting—very nearly, if not exactly, inversely as the viscosities. For in stopping, as in starting, there is a critical value of (speed times viscosity divided by load) below which the oil film cannot be maintained, and friction changes to mixed fluid and solid friction and slipping or rolling of solids.

Why the Ambulance Carried Jones

Jones: "I believe that if it were raining cats and dogs, snowing in July, or the moon should turn blue, that fellow would make light of it."

Jones: "Optimist?"

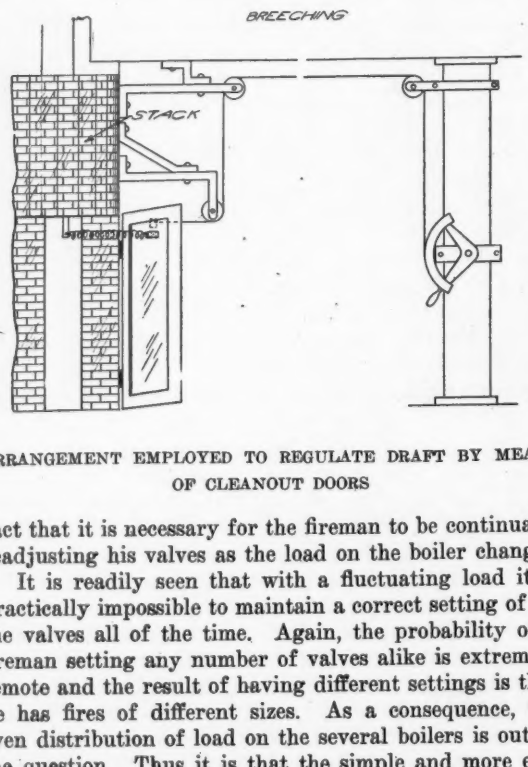
Jones: No; dynamo attendant at the power plant."

Chimney Cleanout Door for Draft Regulation

SUCCESSFUL UTILIZATION IN OIL BURNING PLANT. BY CLAUDE C. BROWN

THE MODERN method of maintaining a given steam pressure in the headers of an oil-burning boiler plant, is to set all of the burner feed valves at the position required for maximum load and vary the oil pressure as the load demands. In other words, when a heavy demand for steam occurs the fuel oil pressure is increased, thereby increasing the amount of fuel oil feed to the burners, and building up the fires under all of the boilers. This method is preferable to that of attempting to maintain a steady fuel-oil pressure and regulating the size of the fires under each boiler by varying the openings of the individual burner valves.

The economy of this system of operation is obvious, as it greatly simplifies the labor necessary in the regulation of the amount of oil burned under each boiler and tends to produce more consistent and uniform results. The method of individual regulation has often been tried and has always been found unsatisfactory, owing to the



ARRANGEMENT EMPLOYED TO REGULATE DRAFT BY MEANS OF CLEANOUT DOORS

fact that it is necessary for the fireman to be continually readjusting his valves as the load on the boiler changes.

It is readily seen that with a fluctuating load it is practically impossible to maintain a correct setting of all the valves all of the time. Again, the probability of a fireman setting any number of valves alike is extremely remote and the result of having different settings is that he has fires of different sizes. As a consequence, the even distribution of load on the several boilers is out of the question. Thus it is that the simple and more economical method of varying the fuel-oil pressure, between pre-determined limits, in accordance with the fluctuating steam demand has been accepted as the standard means of regulating the steam pressure on the system.

In the burning of fuel oil under power boilers, one of the most important essentials is that the draft in the boiler furnace shall be just great enough to provide a minimum amount of air for the complete combustion of the oil injected. In other words, every precaution should be taken to minimize the excess air admitted into the furnace. The degree of draft necessary for perfect combustion of a given amount of oil, for a given load on any boiler is dependent, of course, upon the type of boiler, furnace arrangement, draft resistance of boiler setting and kind of oil used. It has been found that at rating, most boilers require a draft of from 0.10 to 0.25 in. of water, in the third pass.

From the foregoing, it is evident that when the fuel-oil pressure is varied on a given system in accordance with the steam demand, the drafts upon that system must also be correspondingly varied. An increase in fuel-oil pressure means an increase in the amount of fuel oil consumed, and in order to secure the necessary quantity of air to support this consumption, the draft on all of the boilers must be increased.

In one of the California oil-burning plants, the arrangement is such that two breechings are connected to a central stack. On one of the breechings are nine boilers and on the other thirteen. The fuel-oil pressure on all of the twenty-two boilers is maintained by one of two fuel-oil pumps—one being in service and the other acting as a spare. Neither of the breechings contain or are equipped with dampers, but are connected directly into the stacks. At the base of this stack is an iron clean-out door, 3 ft. wide and 5 ft. high.

Many attempts had been made at this plant to regulate the steam pressure by varying the amount of fuel oil fed to each boiler, through the opening and closing of the individual burner valves, the draft on each boiler being regulated by opening and closing its dampers. This method, however, was always found to be laborious and unsatisfactory and was consequently abandoned.

Finally, the method of operation adopted, was that of setting the fuel-oil burner valves and dampers of each boiler for maximum load and of varying the fuel-oil pressure at the pump in accordance with the steam demanded. In this way the fires under all of the boilers were adjusted quickly and uniformly.

The draft was then varied by opening or closing the above-mentioned clean-out door at the base of the stack. The operation of this door was made convenient by means of the cord and quadrant shown on the attached sketch, the door being opened when the fuel-oil pressure was low, thereby uniformly decreasing the draft on all of the boilers, and closed when the fuel-oil pressure was high and all of the stack draft was needed.

This method has since been in use at the plant in question and has proven a very satisfactory and economical method of maintaining the constant, correct relation between the fuel-oil pressure and draft.

In addition to lightening the labor of the operating force, it has proven an increasing factor in the efficiency of apparatus and personnel.

THE ELECTRIC FURNACE in actual use has reached the temperature of 3500 deg. C. Recent experiments have, however, delevoped a furnace which gives a temperature of 4500 deg. C., enough to volatilize diamonds. A comparison of these temperatures with that of the sun, which is estimated at 5000 deg. C., gives a striking idea of what can be accomplished in handling refractory substances with electric heat.—Sibley Journal of Engineering.

JOHN ANDERSON

SEVENTEEN YEARS OF MARINE ENGINEERING GAVE HIM THE FIRM FOUNDATION ON WHICH HIS PRESENT SUCCESS IS BUILT. BY GEORGE H. WALLACE

THERE ARE three reasons why John Anderson was not selected to lead one or the other of the great political parties to victory in November. First, he was born in Scotland; second, he secured his education by hard knocks instead of pine knots; and third, he has a better job.

The subject of our sketch was born in Aberdeen, Scotland, November 18, 1872. Being the eldest living son of a typical Highland clan, he was invited (he admits he was invited), at the age of thirteen, to do something to make the family income larger than the outgo.

He was apprenticed to a machinist and engine builder where he went through all the hard knocks of a Scotch apprentice boy of that day, and supplemented this with a technical course in one of the few night schools of Liverpool, England, assisted by home study.

At the age of nineteen, he was graduated from the shop as a thorough journeyman machinist and engineer, and also from Great Britain altogether. Arriving in the United States, naturally marine engineering seemed the best proposition, and he entered the employ of the International Mercantile Marine Co. in 1890 as an oiler, in the days when ventilation " 'tween decks" was a misnomer. He knows what it is to stand between a battery of ravenous Scotch waterbacks with the thermometer hovering around 145 deg. by the clock. This temperature gave him the idea which eventually placed him at the head of his profession.

From 1890 to 1907, he filled every mechanical position in the gift of his employers up to chief engineer of the line. During the year 1898 he was first assistant engineer of the swift liner "St. Paul," which was taken over by the Government during the war with Spain. She was commanded by Capt. C. D. Sigsbee, who also commanded the battleship Maine when it was destroyed in Havana Harbor early that year. Thus was John Anderson made a commissioned naval engineer of the scout cruiser "St. Paul."

Owing to the enormous size of the "St. Paul" she was denied naval activity with the big fleet off Santiago at the time of the enemy fleet destruction, but as sometimes happens in isolated cases, reaped a full measure of glory when she sank the Spanish torpedo boat "Terror" near Porto Rico Harbor in July, 1898. A number of direct hits so demoralized the enemy that their gunnery was practically nil and not a single torpedo was launched. This battle cleared the western hemisphere of enemy war vessels, and one of the three decorations received by John Anderson during the war was won in this battle for service in the engine room of the "St. Paul."

In the 17 yr. of his life spent at sea, Mr. Anderson crossed the Atlantic ocean over 480 times. Having reached the limit of his opportunities, but not of his capabilities, he left salt water in 1907 to take the position as engineer in charge of steam heating with the Union Electric Light & Power Co. of St. Louis, which position he held for 7 yr., when he was promoted to chief engineer of the Power Plant Department of the Milwaukee Electric Railway & Light Co., a sister organization.

In this position, which he still holds, he has charge of design, construction and operation of all this company's power plants and heating systems in Wisconsin.

It was while acting in this capacity that he became interested in the possibility of burning pulverized fuel under central station boilers, and his mind went back to those horrible days on the Atlantic when he himself furnished the motive power for a No. 7 scoop in a temperature that would fry eggs.

He glanced at the prospects of today, when labor is an almost unsolvable problem and then looked into the future. There stood out in bold relief the one word, WHAT? He settled the matter in his own mind; he decided that conditions in boiler rooms of today and tomorrow had passed the job-lot stage and that the

future demanded not only an increase in heat units extracted from the coal, but *all* of them.

With this idea in mind, he made a large installation for burning pulverized coal in one of his many power plants and personally followed every development. Today he has the largest, most efficiently successful central station plant burning pulverized fuel, in the world, and through actual experience has demonstrated the advantages of the system so far as is necessary to warrant his company making the installation of machinery for burning pulverized fuel in the new 200,000-kw. station now under construction for the Milwaukee Electric Railway & Light Co., located on Lake Michigan, a few miles south of Milwaukee.

During the World War, Mr. Anderson's long and successful marine experience was brought to the attention of Secretary of War Daniels, and he was selected on his merits as Consulting Engineer for the Transport Branch of the U. S. Navy, Department of U. S. Naval Service on November 11, 1918, covering the operation of over 500 vessels. This department was organized on a basis of 1700 vessels, most of them to be available for service by the first of 1919 ready to push men, money and munitions across the Atlantic on a bridge of ships if Germany hesitated to "come across." In this position Mr. Anderson has the unique distinction of being the only civilian in the U. S. Naval Service in charge of uniformed officers and men, and was jocularly known as "the only man on Secretary Daniel's pay roll."

John Anderson was one of what is generally known as "the three Jacks" who graduated from the marine service and attained positions of national and international prominence ashore, one being "Jack" A. Stevens, well known as chairman of the A. S. M. E. Board of Boiler Rules, and vice-president of the A. S. M. E. The other was "Jack" Hunter, who later became vice-president of the A. S. M. E. and one of the board of managers. These three "Jacks" were close companions and were a good "hand" to open any kind of a mechanical jack pot.

When the subject of this sketch was but a small boy, his father took him to visit the new liner "City of Paris" of the American line just off the ways. The power department interested the boy immensely. "Lad," said the sturdy chief engineer of the boat, "if thee minds thy p's and q's and studies thy beuks (books), some day thee cans't be chief engineer of a boat like this." Twenty years later John Anderson relieved this grizzled veteran of the throttle as chief engineer of the "City of Paris."

"Have I a photograph of myself? Not guilty. I'd sooner dive under a vessel and put a new blade on the propeller than look a camera in the face." However, after considerable of this information was secured from various sources, he was induced to face the firing squad and you will see that John Anderson is a man of mild manners, a firm jaw and clear eye. He is still a comparatively young man. The writer first met him at his pleasant home in Milwaukee, after all of the foregoing had been written and found him surrounded by a happy family enjoying the life that duty denied him when he frequently crossed the ocean months at a time without setting foot on shore.

Water Gas Meter Explodes

AMONG the dangers around public utilities there is none more potent than a mixture of gas and air, and in spite of all instructions and warnings, men will take chances frequently with disastrous results. Evidence of this is shown in the accompanying illustrations, one view being from the inside, the other from the outside of a power plant in the West where a water gas meter exploded.

VIEWS OF GAS METER AFTER EXPLOSION

The meter had just been installed and while the workman was waiting for it to fill preparatory to putting it into service, he sat upon the meter, rolled a cigarette and struck a match. Evidently there was a leak in the meter and the flame was communicated to the interior which contained a mixture of gas and air. The explosion which followed killed the workman, destroyed the meter and did a great deal of damage to the building.

Why take chances when we know that results like this are likely to occur?

Water Power the Key to Macedonian Enterprise

MACEDONIA'S estimated 340,000-hp. resources are being investigated by a number of Greek capitalists who, according to accounts published in the "Economic Review," estimate the cost of its utilization at Fr. 500 mill.

To American Red Cross workers who have labored in Albania and other points adjacent to the country that was ancient in the days when St. Paul preached there, the announcement will be welcome news. They, more perhaps than any others, realize what an industrial rehabilitation will mean in the social progress of a noble and intelligent people hitherto handicapped only because their country's economic advantages had not been properly exploited.

Only one-seventh of the electric current to be generated will be used for Salonika and its environs, according to the report; the other six-sevenths are to be conducted to Athens. This innovation, it is believed, will materially lessen the price of electricity in Athens, while new industries as well as mining and agricultural enterprises will be made available all along the section from Macedonia to the Greek capital.

Concrete Fuel Oil Storage Tanks

THEIR PRACTICABILITY PROVEN BY YEARS OF SATISFACTORY SERVICE; PROCEDURE TO BE FOLLOWED IN THEIR CONSTRUCTION. BY J. E. FREEMAN

DURING the past year a considerable number of industrial and public utility corporations have either changed their power plant equipment from coal to oil-burning in order to reduce fuel and labor costs or else they have put in oil-burning apparatus as auxiliary equipment so that the trouble resulting from temporary shutdown through possible failure in the coal supply might be avoided. The difficulties of the past two winters have shown the wisdom of such a course and installations of similar character may be expected in the near future at other plants.

Recent articles in the technical press on the use of oil for firing power boilers, etc., have set forth its advantages through ease in operation, cleanliness and economy in labor so that there is no need to discuss them here; but at many plants, concrete tanks have been constructed to provide the necessary storage facilities, and a description of several such tanks with some mention of their advantages and general method of construction may be of interest.

"But, can a concrete tank be built to hold fuel oil successfully?" is the question that may arise in the mind of the reader unfamiliar with such work. The answer is found in the fact that many concrete tanks are in use today and are giving satisfactory service without signs of any seepage of oil or any effect of the oil upon the

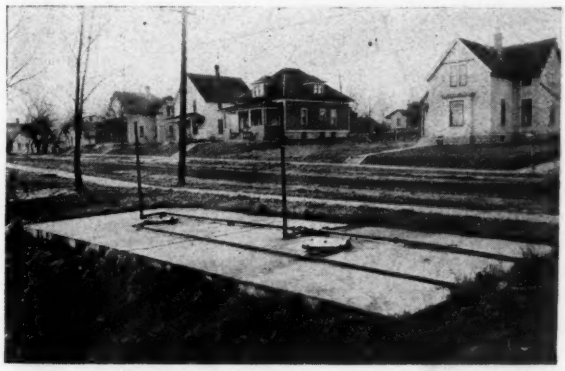


FIG. 1. A GAS OIL STORAGE TANK AT AUSTIN, MINN.

concrete. Tests made by the Bureau of Standards upon various grades of mineral oils including those classed as fuel oils have confirmed these field results. Some of the tanks in service have been given a special oilproofing treatment on the inside, but in the case of others reliance has been placed entirely upon design and good dense concrete finished smooth on the inside surface.

Doubtless the thought arises in the mind of the reader as to whether such tanks have been in use long enough to demonstrate their practicability and durability for oil storage, considering that their general use is a comparatively recent development. Investigation of this subject, covering the past 2 or 3 yr., has disclosed the existence of concrete oil tanks still performing their duty satisfactorily after 15 yr. and more of service. The Baumé gravity of the oil stored ranges from the 14 to 16 deg. oils of the California and Mexican fields to the lighter 30 to 35 deg. fuel oils which are obtained in the refining of the Mid-Continent crude oils from the production of gasolene, etc.

One of the oldest examples—a concrete tank at the plant of the Tonopah Mining Company of Nevada, formerly the Desert Power & Mining Co., at Millers, Nev., was built in 1906. The oil stored in it has a Baumé gravity of 14 to 16 deg. Evidence of its success is found in the word of the superintendent:

"The reservoir was constructed in 1906 and has been in use from then to the present time. It has been entirely satisfactory and no trouble has been experienced."

The San Antonio Public Service Co., formerly the San Antonio Gas and Electric Co., built its first underground concrete oil storage tank in 1905 for storing 180,000 gal. This was followed by another tank of 40,-

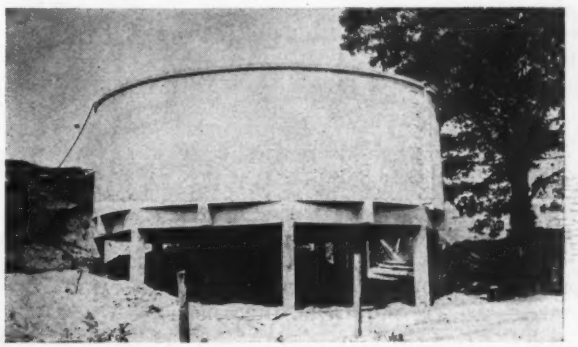


FIG. 2. FREQUENTLY THE USE OF AN ABOVEGROUND STORAGE TANK WILL PROVE ADVANTAGEOUS

000 gal. capacity in 1912, then a 200,000-gal. tank a few years later and finally a 400,000-gal. tank in 1917. The smallest tank contains lighter oils used in the manufacture of water gas, while the others hold the heavier Mexican crude oil of 12 deg. Baumé gravity and 26 deg. Texas fuel oils. No coatings were used on the inside surfaces and periodic examinations have disclosed no signs of deterioration of the concrete. Test pits dug outside several of the tanks to expose the exterior wall surface have shown no discolorations indicating leakage of oil through the concrete, excepting in the case of the first tank built where construction seams or day's work planes in the walls caused some seepage of oil. On later tanks the walls were constructed in a continuous operation and these seams eliminated.

The steam plant of the Southern California Edison Co. at Long Beach has 10 underground tanks of concrete built at various times during the period from 1911 to 1913 for the storage of crude California petroleum of 18 deg. Baumé gravity. The tanks have a capacity of 30,000 to 400,000 gal. and though in continuous service since construction, are still "in first class condition" according to the company's construction engineer.

One of the first tanks developed some seepage through small cracks which the engineer considers due to work-

manship, since it was not repeated; the oil appears to have penetrated the concrete about ⅛ in., but otherwise the concrete is in perfect condition.

In the same state, the Napa Valley Electric Co. has a 10,000-gal. oil tank at St. Helena, built in 1912. The Indian Valley Railway Co. has a 32,000-gal. tank at Paxton, built in 1917, and the Foreman Light & Power Co., a 10,000-gal. tank at Foreman completed last year for the storage of 26 to 30 deg. oil.

Good examples of the storage of lighter grades of oil are the two 25,000-gal. tanks at the plant of the Southern Nebraska Power Co., Superior, Neb., built in 1916. Fuel oil of 36 to 38 deg. gravity is stored in these tanks and careful measurements have failed to show any loss of oil through seepage. No special surface treatment was applied to the concrete.

FIG. 3. AN UNDERGROUND TANK DOES NOT INTERFERE WITH YARD SPACE AND CAN BE PLACED IN CONVENIENT LOCATION WHERE AN ABOVEGROUND TANK WOULD BE IMPOSSIBLE

Other examples of underground concrete oil tanks at plants of public utility companies, though of more recent origin, are those built for the Southern Utilities Co. at eight different cities in Florida, including Miami and St. Augustine, also one for the Savannah Electric Co. at Savannah and the Gas Light Co. of Columbus, Ga. These vary in capacity from 15,000 to 50,000 gal. Reference has been made to power plants of public service companies only; but when it is considered that including tanks at industrial plants, oil storage reservoirs at refineries, etc., there are about 500 concrete tanks in use over the country representing close to 900,000,000 gal. capacity, the value of this method of storage cannot be doubted.

Tank Construction Details

Whatever the gravity of the oil to be stored in the tank, there are a number of fundamental principles which must be adhered to if a successful result is to be obtained. One is continuity of construction. Small tanks should have walls and floor built in one continuous operation, and on larger work the placing of concrete should be arranged so that the floor, walls and roof will each be constructed as a unit without construction joints or day's work planes. The experience of the San Antonio Public Service Co. illustrates this point. Construction joints in the walls of the first tank built at this plant were responsible for subsequent leakage, but with the succeeding tanks care was taken to build the walls in a continuous operation, the result being an oil-tight structure. In recent years, some tanks have been built by contractors using sliding forms similar to those used for the construction of circular grain bins, where the form is gradually moved upward as concreting progresses by turning at frequent intervals the screw-jacks supporting the forms and clamped to vertical rods or pipe embedded in the wall. The forms must be raised at such a rate, however, that the concrete to be exposed on raising them has had time to harden sufficiently to sustain the weight of the concrete above without sagging or distortion, but the rise must not be so slow that the forms stick.

When unforeseen accidents or other conditions interrupt continuous wall construction, the surface of the concrete previously deposited should be thoroughly roughened and washed clean with a hose, a mixture of 1 to 1 mortar about 1 in. in thickness spread over the surface, and the new concrete deposited immediately thereafter.

When the size of the tank necessitates a construction joint between floor and walls, a groove or recess should be provided in the floor to key in the wall and a galvanized iron strip about 8 in. wide with joints soldered and riveted so as to make a continuous band, inserted on one side of the recess so that about half will be embedded in the floor and half in the wall when constructed. The floor surface to be covered by the wall should be roughened and cleaned before concrete for the wall is deposited.

FIG. 4. THE INTERIOR OF THE CONCRETE TANK MAY BE GIVEN SPECIAL SURFACE TREATMENT DEPENDING ON THE CHARACTER OF THE OIL TO BE STORED

Since it is important to obtain a smooth inside surface, particular attention should be given to spading the inner face of the wall. The proportions of concrete recommended for oil tanks, one cement, one and one-half sand and three stone or pebbles, make it comparatively easy to secure the desired result. Better work can be accomplished with 1 by 2-in. wooden sticks planed smooth, having a sheet steel blade at the lower end, than by heavy spades, and workmen should be assigned to this job so that spading can proceed continuously.

The consistency of the concrete is another important factor. Too much water is as bad as too little, for it

seriously affects the strength of the concrete. A safe rule is to use the least amount of water in mixing the concrete which it is possible to use and still obtain a workable plastic mixture which can be worked thoroughly into the forms and about the reinforcement. The proper consistency might be termed "quaky." Because uniformity of the concrete is vital to the success of the work, concrete should always be mixed by machine in a batch mixer so that separate and uniform proportions of each of the materials can be maintained at all times.

Immediately after wall forms are removed all projections and irregularities on the exposed surfaces should be carefully removed and any cavities or pockets filled with mortar of the same proportions as the concrete. The inner surface of the walls may then be further finished by wetting and thoroughly covering with a grout of cement-sand mortar, equal parts, rubbed in with a carborundum stone or concrete brick. This is not a surface wash but a method of surface treatment which is much more efficient.

The investigations conducted by the Bureau of Standards previously referred to showed that oil of 30 deg. Baumé or heavier can be stored in untreated concrete tanks successfully, and some of the examples listed have already demonstrated this conclusion in the field. For lighter oils, however, present knowledge indicates that some surface treatment is desirable as a further factor of safety, supplementing careful design and construction. Fuel oils above 30 deg. Baumé are being stored successfully in concrete tanks treated with a solution of magnesium fluosilicate or similar liquids which form an insoluble lime compound that fills up the surface and checks the tendency of the oil to penetrate the concrete. There are a number of contractors specializing in concrete oil tank construction who have worked out treatments of their own, while other coatings are marketed by manufacturers of concrete paints, etc.

To cover all the construction features in detail is not the intention of this article. A tentative recommended practice for construction of concrete fuel oil storage tanks which gives this specific information has been prepared by the Committee on Concrete Tanks of the American Concrete Institute, and any readers desiring the data can easily obtain it from that society. As far as the design of the tank is concerned, each is a separate problem which must be worked out according to the conditions to be met. This can be handled by concrete engineers or by engineering contractors who are familiar with such work. Several well-known firms installing oil-burning equipment are also prepared to undertake the design and construction of underground concrete tanks as a part of the layout.

To sum up—accumulation of an adequate fuel supply to avoid possible shutdown of plant during the winter is of the utmost importance. Many plants have changed from coal to oil-burning equipment to benefit by the economy in labor required for operation and the ease of storing fuel supply underground, thus saving yard space. Concrete tanks have proved most efficient for the storage of oil in this manner.

Oil-burning equipment can also supplement the regular coal-fired plant with relatively few changes in existing equipment, thus providing a fuel reserve. It is a valuable form of insurance against loss of production which the power plant manager cannot afford to overlook.

The Cranky Pump

By John S. Carpenter

IT was not what you would call a comfortable situation. The Chief scowled whenever he looked in the general direction of the pump that was doing all the mule tricks. To be sure, it was only of two and a half million gallons per day capacity, against 150 ft. head and driven by a 100-hp. motor. Much bigger pumps have been made and run year in and out. No possible kick could have been made about the suction lift, only 6 ft., or that the arrangement of the piping queered the job. Taken as a whole, it was just a small city waterworks proposition pumping against a standpipe load, involving nothing unusual or novel.

Also, it was the day for the official test to be pulled off. The builder's representative and engineer, Mr. Graham, was on hand and looked worried. The contract had been taken under severe competition and things looked hopefully toward taking out the pump and putting in a new one, or trying out a few new impellers at least; all of which looks to the merest layman as if the designer's calculations were largely of the "hit or miss" type, and speaking generally inspire anything but confidence. It is usually at such a time that some boob comes along and asks that famous question, "Well, what's the matter with it?" which is an open dare to commit murder.

"Every darn time the Venturi shows that she is going at 1450 gal. per min., only 80 per cent capacity, she cuts off!" cussed Graham, the company's engineer. "She ought to handle 1800 without four-flushing."

"It's worth a box of good cigars to know what's spoilin' the party," his erector meekly responded. "I'll bet them fellers in the 'Engineering Department' has introduced some new droopin' characteristic curve that ain't been approved by them Paris dressmakers. If they tied it to this job, it sure is a bird!"

"What nearly kills me," continued Graham, "is that we can't find any lost monkey wrenches in the runner, or overalls in the piping or any other old-time stalls. I'll try and get the test shoved over two days and wire the office. You better take down the whole pump and try once again to find the bull."

As Jimmie rolled up the hand crane, Graham went into the Chief's office and from there to the telegraph office. He wrote:

"Discharge breaks down at 80 per cent capacity, have examined everything very carefully, find nothing to cause abrupt break in discharge. Efficiency satisfactory up to point of break. Examine impeller design for trouble and wire at once care Shawnee Hotel.

Graham."

Graham went to his hotel and up to his room. He lit a cigar and sat down to think of all the queer things

he had ever known pumps to do. Between himself and his cigar he admitted that was his star trick pump, a pippin, if you like—but all the same it had him going. He was still deep in his thoughts when Jimmie, his erector, came in and handed him a sketch of the impeller with the inlet and discharge angles marked on it; suggesting that he might check over the angles and possibly find something to blame the queer doings on.

But the Chief Engineer of the waterworks did not like the idea of waiting longer for the official test and then putting the pump on the line when Graham was satisfied to hand it over. He told Larry, the operator, to go carefully over all the piping that concerned the new pump, from the foot valve to the standpipe connection. Larry saw the kind of a mild, gentle gaze that the Chief wore and lost no time doing what he was told.

Next morning the hotel clerk handed Graham a telegram from the office reading:

"Pump is Design C, Type DP, with new drooping characteristic; have checked over impeller design and find it O. K. See if suction pipe well immersed, at least 3 ft."

"I told yer about that new drooping characteristic stuff," snapped Jimmie, "an' I'll bet that Type DP bunk means 'darn punk!' "

"You may be right about that," returned Graham. "But I don't see that it gets us anywheres. I think we better quit, we're a couple of hasbeens."

"Well," said Jimmie, after a little silence, "the thing stands just where it was yesterday, that meanin' that we ain't found out what's phony yet."

When the two got to the plant, the Chief called Graham into his office.

"Mr. Graham," the Chief began, "we need that pump on the line as soon as we can get it. The old steam pumping engine was tested out for slip this morning and I hate to tell you how much it was slipping. That means trouble if we don't get at it soon."

"It can't be that I haven't been trying to give you the pump, can it?" Graham asked him.

"No, I don't say that at all. Under the contract terms the test should have been held yesterday and I willingly gave you two days more because I thought that there might be a leak in the piping. I do know that queer things do happen, and the queerer they are, the harder they are to find. I feel I must tell you to have it ready for test tomorrow or we may be in a bad fix."

"Well, I'll do what I can to get to the bottom of the trouble by then," agreed Graham.

"All right, then I'll wire the consulting engineers right away."

Graham joined Jimmie out in the pump room. They started up the pump again and it did a trifle better, 1550 gal. That encouraged them a little, but it still was short of 1800 gal., the contract amount. To help things a little, they left the pump on the line for the rest of the day and set it so that it would not go above 1400 gal. per min.

The next morning, Graham got permission to take the pump off the line, as the water level in the reservoir was high enough so that the old pump could handle the load at about half capacity. He tried the pump out again at maximum speed and with the discharge valve wide open and to his dismay the thing cut off again at the old place. That riled him and he wired the factory:

"New drooping characteristic all bunk, works fine at 80 per cent capacity. Suction pipe immersed 5 ft. Official test today. GRAHAM."

in which the reader, if he looks very carefully, will find a slight trace of sarcasm.

After dinner, the consulting engineers came in, four strong. For a half hour preparatory to the test, they were closeted with the Chief Engineer in his office. Graham felt and looked downcast. Jimmie made no attempt to jolly him along because he was about as much disgusted. They both imagined they could feel the Chief roasting them, their pump and their firm. Graham busied himself figuring the efficiencies at different capacities, while Jimmie cleaned the rust off some of the casing bolts. Their only comfort was a few words from Larry, the operator, to Graham, "Don't take it so hard, maybe she'll do better on test."

"Thanks, Larry," returned Graham, "but I'm afraid there's a nigger in the woodpile some place here."

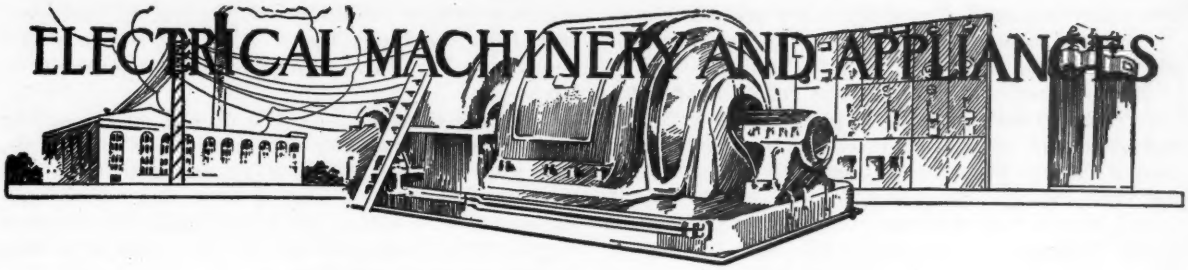
The consulting engineers came out of the Chief's office led by the Chief. The introductions were brief and formal and reminded Graham for all the world of the preliminaries to a wake. The Chief was dressed in a new black suit and his tone and bearing was comforting and consoling. Graham wondered, "Why the undertaker look and consolation?"

Larry, on an order from the Chief, started the pump. All eyes turned to the Venturi card and watched the little indicator draw a red line as the pump gathered speed. Now it stood at 1200 gal., 1400—1600—1800!—2000! What had happened? The pump was now handdling about 11 per cent more water and the head was 5 ft. above the contract head. They all looked at each other. No break yet and the pump ran as smooth as could be desired.

The Chief ordered it shut down. This time he started it himself, and let it go up to speed very slowly; 2000 gal. was reached in the same way! The engineers, with the Chief, went to the switchboard and took readings for efficiency computations. Meanwhile Larry "snuck" over to Graham, saying, "I thought it would do a sight better on test; just before you started up, I went down and took a good look at the foot valve; I found the screen basket loose and covered with dirt and leaves. My guess is that when you got up near capacity the suction got that strong that she pulled up the basket and cut off the end of the pipe and made the pump shut down. That makes me think how she cuts off at 1550 gal."

Graham stared at Larry and held out his hand, saying, "Say, Larry, do you want a good job with us?"

"EVERY YEAR, and age, and almost every day, sees some new scheme sprung that promises to give us more of this world's goods and with less work. First, it is pure, fiat money with nothing back of it but a printing press. Then it is a minimum wage, then a single tax, then minimum hours of work, and then a community form of government and equalized living conditions—and the changes are rung and rerung, in new garb, to muddle and befog each generation. Many men spend more time talking and pushing these things than they spend in training themselves to be good workmen—and for lack of being good workmen they never make much of a success in life."—Henry L. Doherty, in Forbes Magazine (N. Y.)



The Lighting of Power Houses

REQUIREMENTS FOR THE VARIOUS SERVICES AND THE MEANS BY WHICH THEY MAY BE FULFILLED. BY A. D. BELL*

IN ORDER that the supply of energy from a power house may be continuous, it is necessary that control supervision be maintained at all times. An efficient lighting installation will be of great aid in accomplishing this.

Good lighting permits the proper supervision to be made with ease and facility and the danger of coming in contact with moving or electrically charged apparatus is decreased. It is important, both from the humane and the economic standpoint, that the employer have as few accidents as possible. Accidents are demoralizing to the whole working force and cause the services of

FIG. 1. A DIFFUSING UNIT SUITABLE FOR GENERATOR AND CONTROL ROOM SERVICE

those injured to be lost and at the same time the employer is generally liable for the injuries incurred; hence the value of good lighting is obvious.

General illumination has been found to be most satisfactory. It consists in having the lamps and the reflectors so arranged about the room that all parts will be well lighted, and objectionable shadows prevented. The general effect is pleasing to the eye; the light is evenly distributed and any accumulation of dust or dirt will be shown up at once, and the tendency will be to make the operator keep the plant clean and safe. In case a higher intensity of light is required at some particular point in the room, this can be provided by having a closer spacing of the units in that part, and still retain the general lighting scheme of the rest of the room. Such a system is known as "localized general illumination."

*Of the Edison Lamp Works of General Electric Co.

Throughout the power house, it is important that there be no glaring source of light, as such light can easily cause temporary blindness and result in accident. Special attention should also be paid to the spacing of the units, so that there will be no dark aisles or dark spaces between machines. To provide for a possible shutdown of the plant, or failure of the regular source of power, it is customary to have an automatic throw-over switch to transfer part of the lighting circuit to battery or other auxiliary lighting sources.

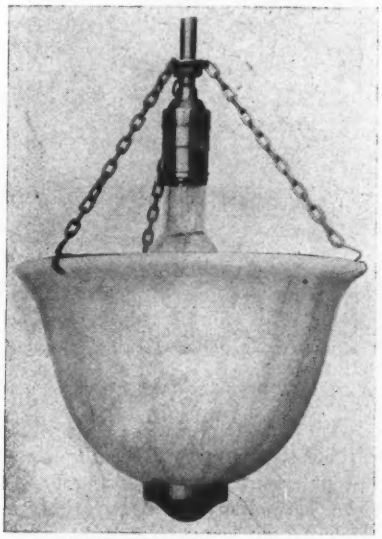


FIG. 2. SEMI-INDIRECT UNIT FOR OFFICE WORK

Mazda lamps are very satisfactory for power house lighting on account of their high efficiency, long life, ease of installation and pleasing quality of light. They are available in a large range of sizes, for all standard lighting circuits in both series and multiple types.

Types of Mazda lamps to be used will vary; but wherever feasible, those of the C type should be used, as they are the most efficient. The fixtures in all cases should be hung close to the ceiling in order to give a good distribution of light.

A system of maintenance and cleaning of the fixtures should be provided in order to get the maximum efficiency of illumination. All units collect more or less dust and the lamps will become blackened and burn out as their period of life becomes shorter. Experience has

shown that frequently a good lighting system has gradually become poor and inefficient due simply to lack of attention.

Light-colored walls and ceilings reflect light much better than darker ones, and if possible, the walls and ceilings should be painted some light color. Besides making the lighting more efficient, they have a cleaner and more cheerful appearance.

R.L.M. standard dome reflectors with bowl enameled Mazda C lamps will provide suitable light for general interior illumination at the hanging heights ordinarily encountered. These reflectors are made of steel, have a reflecting surface of white porcelain enamel and when used with bowl enameled Mazda C lamps, well diffused illumination with little glare will result.

In the case of large power houses, such as are found in cities or larger municipalities where these buildings are more or less show places, and the good will of the public is sought through advertising and publicity, it

FIG. 3. A DIFFUSING UNIT SATISFACTORY FOR OFFICE LIGHTING

may be desirable to use more decorative fixtures. Fixtures of the opalescent globe enclosing type such as is shown in the accompanying illustration, are recommended. This fixture is made of opalescent glass and produces a desirable distribution of well-diffused light.

Such fixtures as mentioned above could be well used in the generator room and control room. These rooms are generally kept clean and in good order, and are the show places of the plant.

Following detailed directions indicate the general illumination requirements for the different parts of the plant.

Generator and Engine Room

This is generally quite roomy and often has a high ceiling. In case the turbine and flywheels are especially high, particular attention must be paid to the spacing of the units in order to prevent shadows. An intensity of at least five foot candles should be provided, to enable one to observe the operation of the machines at all times and to make such repairs and adjustments as may be necessary without recourse to drop lamps. If opalescent enclosing globe fixtures are used, slightly over one watt per square foot should be provided, using Mazda C lamps.

The size of lamp used will depend on the ceiling height and arrangements of machines. For example, with a ceiling below 12 ft., 100-w. lamps on 10-ft. centers might be employed close to the ceiling. If the ceiling were 20 ft. in height, 500-w. units on centers approximately 22 by 22 ft. could be hung 20 ft. above the floor and produce the same effect.

Gate House

In the gate house of a hydroelectric plant are located the controls by which the flow of water into the turbines is regulated. Their operation is relatively simple and the lighting requirements are not high. Seventy-five watt bowl frosted Mazda C lamps in R.L.M. standard dome reflectors, with hanging heights of 10 to 12 ft. and spacing approximately 10 to 12 ft. will be satisfactory. In other words, 0.6 to 0.8 w. per sq. ft. should be provided.

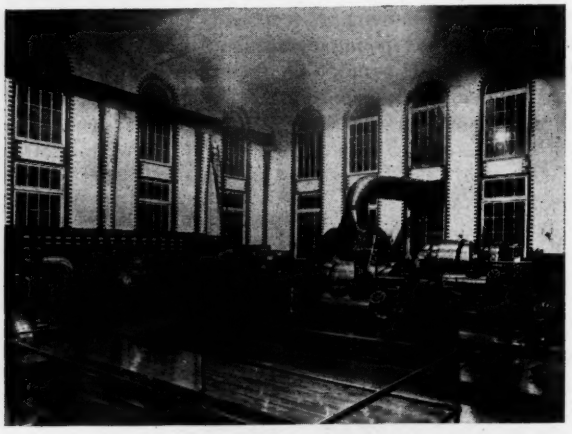


FIG. 4. GENERATOR ROOM LIGHTED WITH 750-W. MAZDA LAMP IN ENCLOSING GLOBES

In the lower part of the gate house the actual regulating machinery is located and sufficient light should be provided there in order that inspection and repairs may be made. As the atmosphere is moisture laden, vapor-proof units are desirable. An intensity from two to three foot candles will be sufficient. The exact size of lamps and the location of the fixtures will depend entirely upon the local conditions.

Transformer and Switch Room

It is necessary that this part of the plant be especially well lighted. With good light there is little danger of accidental contact with the electrically charged apparatus and less likelihood of making mistakes in manipulating the switches which control the high-voltage circuits.

An intensity of from five to eight foot candles should be provided. This will require slightly over 1 w. to 1.6 w. per square foot with hanging heights from 12 to 15 ft. Two hundred-watt Mazda C lamps in R.L.M. standard dome reflectors hung on 12-ft. centers will be satisfactory.

The units should be so spaced that the wires and connections coming in to the rear of the switchboards may be easily seen and repaired.

Control Room

The control room should have good illumination in order that the dials and switches may be clearly seen. A mistake in instrument reading or in the throwing of a switch may cause serious results and the likelihood of such errors may be largely overcome if the operator is able to see clearly what he is doing. An intensity from six to eight foot candles will provide good illumination. This will require over 1 w. to 1.6 w. per sq. ft. Enclosing globe fixtures will be suitable here. With the ordinary hanging heights from 12 to 15 ft., 200-w. lamps on 121-ft. centers will give satisfactory results.

Boiler House

The boiler house as usually seen is a dark and dingy place. It is true that the lighting requirements are not especially high, but sufficient light should be provided to operate the boilers and to keep the place in good order. It will be an incentive to the operators to keep the place cleaned up if the lighting is sufficient to show

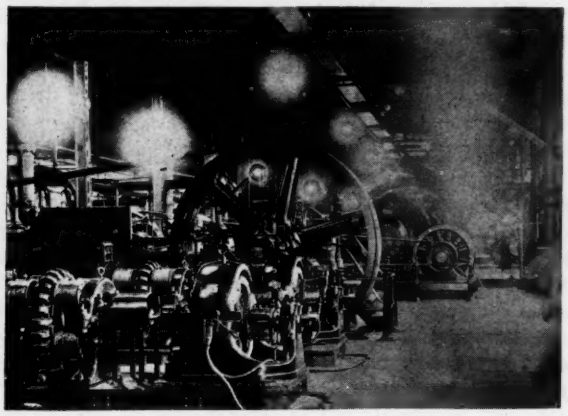


FIG. 5. ENGINE ROOM LIGHTED WITH MAZDA LAMP IN FLAT-DOME ENAMELED REFLECTORS

up the dirt. Special attention should be paid to the location of the lighting units in regard to the stoking apparatus to prevent dense shadows. The firemen should be able to see clearly what they are doing at all times and operate efficiently. This condition can be met with an average intensity of three to four foot candles, which would be secured with the use of 0.6 to 0.8 w. per sq. ft., with Mazda C lamps. A typical layout might well be 75-w. Mazda C lamps in R.L.M. standard dome reflectors on 10-ft. centers hung from 10 to 12 ft. above the floor. On account of the great amount of dust present the periods between the cleanings of the system should be especially short. Local lamps in half shades should be provided for the gages in order that they may be easily read.

The ground in the immediate vicinity of the boiler house should be well illuminated, especially with reference to the fuel supply. Deliveries of fuel may be made at night, and supply should be easily accessible at any time. Type of fixtures to be used for this will depend entirely on the requirements at the individual stations. In general, the pendant type of fixture giving a wide distribution of light is preferable. The ordinary forms of street lighting units in some cases will prove satisfactory. Fixtures may be hung on brackets from the sides of the building or on posts depending on structural arrangements. However, the area to be illuminated is at a considerable distance from where it would be practicable to install a lighting unit. Floodlighting can be used to advantage.

Offices

The offices will perhaps require a more ornamental type of unit, with a rather high intensity of light, eight foot candles being recommended. The opalescent enclosing globe type of fixture as shown in Fig. 3 is recommended, as it produces a pleasing and well-diffused light. A semi-indirect fixture such as is shown in Fig. 2 is also satisfactory. To utilize such units fully, however, it is necessary that both walls and ceilings be light in color.

FIG. 6. DOME REFLECTOR FOR USE WITH CLEAR, BOWL FROSTED OR BOWL ENAMELED LAMP

One and six-tenths watts per square foot is the approximate requirements to produce the necessary light.

These recommendations have been made to cover the average conditions found in a power house. The actual lighting requirements will of course depend upon the individual surroundings and the factors in each case.

The Bureau of Mines has recently issued Technical Paper 238, "Indicators for Carbon Dioxide and Oxygen in Air and Flue Gas," by L. H. Milligan, D. O. Crites, and W. S. Wilson. The report describes the construction and method of using three types of portable indicators developed by the Bureau of Mines in its chemical research laboratory at Pittsburgh station, one for determining the CO_2 content in air, one for determining CO_2 in flue gases, and the third for determining oxygen in air.

Exciters and Systems of Excitation*

Types of Machines and Methods Employed to Insure Continuity of Service and Economical Operation. By H. R. Summerhayes

IN laying out the excitation system for the generators of a power station, the primary requirement is reliability. First cost and economy in operation are secondary, but, nevertheless, must be given consideration.

To meet the first requirement:

1. The exciters should be machines of good design and liberal size.

2. The method of drive should be reliable.

3. All electrical connections and wiring should be as short and simple as possible, and located and supported to be safe from external injury.

4. Method of control should be simple and reliable, and operation convenient.

5. Reserve capacity and driving source should be supplied.

The systems of excitation which have been used or proposed may be divided into two general classes:

1. Common excitation plant (exciters operating in parallel on a bus supplying excitation to all generators).

2. Individual exciters (not operating in parallel).

Comparison of Various Plans of Excitation

Common excitation plants in which the exciters are operated in parallel on a common bus have the advantage as compared with individual exciters that the bus voltage is kept constant, so that a storage battery may be kept floating on the bus at all times ready to take up the excitation load in case of exciter trouble, also that the constant voltage exciter bus offers a source for the supply of lighting, auxiliaries, and sometimes the control of electrically-operated switches. If automatic voltage regulators are used directly on the exciters, this constant voltage is no longer maintained and this advantage disappears unless a regulator is used on a booster between the constant-voltage exciter bus and a varying-voltage bus to which the generator fields are connected. These common excitation plants have the disadvantage that any trouble on the main exciter bus may cause a shut-down on the entire generating station.

In the case of individual exciters, where one exciter is supplied for each machine and the exciters are not normally operated in parallel, trouble on one exciter circuit will only affect one generator. The exciter circuits are short and simple and not liable to trouble.

Whether the common excitation plant or individual exciters are used, the method of drive is important.

For individual exciters, usually only two methods of drive are used; namely, exciters directly connected to the generator shafts and exciters driven by motors.

In the latter case, the motors may be connected to the main bus or preferably they should be connected to an auxiliary bus supplied by an a.c. generator driven by a prime mover.

Transformers are also furnished, so that the motors may be supplied from the main bus in emergency.

This method of driving individual exciters is used chiefly for large hydroelectric plants where on account of the slow speed of the vertical shaft generators direct connected exciters become too expensive. For individual exciters it may be said that direct-connected exciters are preferable on account of cost, reliability of drive and shortness and simplicity of wiring.

Direct-connected exciters large enough to excite two units are sometimes specified. For steam turbines, such large exciters may be undesirable on account of their weight and size, being too great to overhang on extended shaft. For turbines up to 1800 r.p.m., direct-connected exciters are reliable machines and have given good service records. For turbines of 3600 r.p.m., direct-connected exciters are often used; but in order to obtain the best results as to commutation, and make such machines as reliable as those of lower speed, great care must be exercised in manufacture.

In the case of common excitation plant, a number of arrangements for driving the exciters are in use. The most reliable and efficient arrangement is the direct-connected exciter, unless there are reasons, such as too high speed or too low speed, against using it. Belted units are widely used in small plants where the engine speeds are low and the use of a belt involves little risk of trouble. On account of the low engine speed, a considerable saving of cost and space is made by using belted instead of direct connected exciters.

The plan most commonly used for common excitation plant is to have some of the exciters motor-driven through transformers from the main a.c. bus and some of them driven by separate prime movers.

Another plan which has been used in connection with some large steam plants is to have the exciters motor driven from an auxiliary a.c. bus supplied by auxiliary generator units designated as "house turbines." Transformers connecting auxiliary bus to main bus are supplied for emergency use or for adjusting the power on the auxiliary bus for heat balance purposes. This auxiliary bus is used also for the supply of auxiliary power for the whole station, such as circulating water, air, and hot well pumps, stoker motors, economizer and draft fans, coal crushers and conveyors, etc. In large stations an auxiliary bus and its generating unit may be supplied in connection with each main generating unit on the system.

An arrangement commonly used in hydroelectric plants and occasionally in steam plants is to have each exciter connected to a prime mover and to an a.c. motor supplied from the main bus, so that the exciter may be driven by either or both.

This arrangement has been used in steam plants of moderate size and in hydroelectric plants for the following reasons:

1. The reason which applies to both cases is to have two separate sources of power for the exciter drive. In hydroelectric plants for high head where the exciter water wheel nozzles, on account of their small sizes were likely to become blocked, it has been for many years the practice to have an induction motor connected to the bus mounted on the same shaft as the exciter and the water wheel, so that when the water wheel fails to carry the load the induction motor will take it up. In steam plants the chief reason for using this arrangement is to provide means of adjusting the

*Abstract of paper presented at 36th Annual Convention of A. I. E. E.

amount of exhaust steam available to heat feed water, which is done by adjusting the governor of the exciter unit to take more or less power, the remainder being supplied from the motor.

This arrangement in steam plants has the disadvantage that to obtain an efficient turbine the speed must be high, possibly too high for the proper design of the direct current generator, or of the motor, necessitating sometimes a geared connection which, of course, is disadvantageous for a high-speed continuous running unit.

The plan of direct connected exciters on the main generator shaft appears to be the most reliable and simple method of excitation for large plants wherever the speed requirements do not make a direct-connected exciter out of the question.

For all large stations using individual exciters it is desirable to have an emergency excitation bus with a reserve exciter driven by a separate steam turbine, water wheel or motor, so that any generator field may be thrown on this bus in case of trouble with one of the individual exciters. The question as to whether a storage battery is necessary will depend on the number of units in the plant and on the importance of the service.

Voltage of Exciter Plant

For many years, the standard pressure has been 125 v. In recent years, however, 250 v. has been coming into use and has now become standard for large plants for the following reasons:

Difficulty and expense of building high-speed commutators for 125 v., especially turbine-driven exciters or water-wheel exciters which stand double speed. The space occupied by the commutator is reduced at 250 v. Expense of bus bars, machine leads, circuit breakers, etc., to carry the large currents necessary at 125 v., especially in large stations where the field currents are heavy and in long stations where the distances are great.

Excitation Requirements of Alternators

Excitation requirements of alternators vary according to the design, but for modern standard lines may be summarized as follows in per cent of the kv.a. alternator rating:

STEAM TURBO-GENERATORS

1000 to 5000 kv.a.	0.5 to 0.3 per cent
7500 to 35,000 kv.a.	0.4 to 0.3 per cent

WATER WHEEL DRIVEN GENERATORS

1000 to 5000 kw. slow-speed	1.5 to 0.8 per cent
1000 to 5000 kw. high-speed	1 to 0.5 per cent
7500 to 20,000 kv.a. slow-speed	0.7 to 0.5 per cent
7500 to 20,000 kv.a. high-speed	0.5 to 0.4 per cent

MOTOR GENERATORS

1000 to 5000 kv.a.	1 to 5 per cent

Modern exciters are usually continuous-rated machines having no stated overload capacity, so that in order to allow liberal margin for emergencies of operation the full-load rating of the exciter should be 20 per cent greater than the stated excitation requirement.

Shunt Versus Compound-Wound Exciters

The relative advantages and disadvantages of shunt and compound-wound exciters have been frequently discussed; and the selection has sometimes been dictated by the type of excitation plant used; sometimes by individual preference of engineers.

The matter may be summarized under the following headings:

A. Small belted exciters operating in parallel, no battery. Compound generally used to keep exciter bus voltage constant with variation in excitation load due to either variation in a.c. load or to change in the number of alternators in service. With shunt exciters such variations would require adjustment of exciter field rheostats as well as generator field rheostats and the compound are usually preferred for convenience in operation.

If voltage regulators are used, either shunt or compound exciters can be handled equally well.

For this class of exciters standard belted generators are used, which are manufactured and stocked in large numbers compound wound, so that reducing the varieties stocked is another reason for the choice of compound winding.

B. Motor - engine - or water - wheel - driven exciters operating in parallel, no battery.

Compound preferred, for same reason as stated under A.

C. Exciters direct connected to main generating units, operating in parallel, no battery.

Compound preferred for above reasons, but stock requirements do not apply excepting in small units.

D. Exciters operating in parallel, with storage battery floating on exciter bus.

In this case either compound or shunt may be used.

Compound has the advantage of keeping the bus voltage constant with change in excitation load, and the disadvantage of possible reversal and motoring of an exciter in case of failure of its source of power. This contingency may be provided against by reverse-current relays, so far as motoring is concerned, but this may not prevent reversal of the polarity of the exciter due to the sudden reversal of the current in the series field.

Shunt exciters are safer, when in parallel with a floating battery, as regards possible overspeeding due to motoring, in case of failure of reverse current relays. They are certainly less liable to be reversed in polarity when an exciter slows down due to trouble with its drive. They require more frequent adjustment of exciter field rheostats, but have the advantage of omitting the equalizer bus with its extra switches and connections. Commutating-pole shunt-wound exciters should be adjusted to have a drooping characteristic at all operating voltages, not only for proper parallel operation but in order to reduce the liability of reversal.

The shunt winding appears preferable for individual exciters, whether the a.c. voltage regulation is accomplished by the alternator field rheostat or the exciter field rheostat. In the former case, there is no reason for compound winding unless for manufacturing or stock convenience in the smaller sizes. In the latter case, when the exciter has to operate down to a low voltage the shunt winding has more stability, particularly in exciters of the commutating-pole type. The shunt exciter is also less susceptible to reversal by discharge from the alternator field, or by residual magnetic effect from the alternator field.

When a vibrating contact regulator is used to control the a.c. volts pressure through the exciter field there appears to be little choice whether the exciter shall be shunt or compound-wound, so far as the action of the regulator is concerned. For shunt-wound, the field current handled by the regulator is greater. For compound winding, the field current is less, but a greater range of voltage must be applied to obtain the same quickness of regulation.

The shunt across the series field makes the latter a damper winding, which impedes sudden flux changes, but this is partially neutralized by the action of the series field with changes in current.

For sensitive regulation, the shunt machine is undoubtedly better, since the entire field is controlled by the regulation, and on account of the absence of the damper formed by the series winding. For most plants, the compound exciter is satisfactory with a regulator, since its period is usually faster than that of the alternator field.

Voltage Regulators

Large central stations supplying power from the generator bus bars at generator voltage through a multiplicity of feeders have seldom found it necessary to resort to automatic voltage regulation, because the sudden changes of load are small in proportion to the generator capacity.

Exceptions are noted, such as the plants at Philadelphia, Baltimore and Pittsburgh, where unusual requirements in intermittent loads exist, due to the supply of main railway electrification or steel mill loads.

In hydroelectric plants, on the other hand, the power is usually carried through a few large transmission lines, the interruption of any one of which means the loss of a large proportion of the station load, necessitating automatic voltage regulation of the generators. The vibrating contact forms of regulators devised by Tirrill are the only ones in wide use in this country.

These regulators can be made to take care of exciters operating individually or in parallel in sizes up to the largest which it has been found necessary to use. The exciter field current is controlled through relay contacts; the relay coils themselves being actuated by direct current passing through the main regulator contact. Up to about 4 amp. at 125 v., a single relay handles the exciter field current; for larger exciters, the field rheostat is divided into sections short-circuited by a number of relays, the general rule being that each relay will take care of 2 amp. field current; that is to say, for a total of 10 amp. field current there will be at least five relays. At 250 v., half the current is handled. To obtain the best results, the kilowatt output per exciter should not be more than 25 kw. per relay. When the field current is more than 20 amp., it is generally desirable to split the field, so as to keep the actual field current handled by the relays below 20 amp.

Since a 12-relay regulator will handle about a 300 kw. exciter, and regulators have been made with as many as 48 relays, which could handle four such exciters to take care of very large excitation plants.

For still larger plants, if such should be contemplated, other methods of application of vibrating contact regulator may be used, so that we can say there is no limit to the size of plant which can be regulated on this principle.

A single regulator may be used to control a number of exciters operating in parallel, or to control a number of individual exciters not operating in parallel, when the alternators excited run in parallel. It is also possible to use in the latter case individual regulators, and in this case the proper division of reactive component among the alternators is accomplished by a compensating coil on the regulator supplied from a current-transformer connected in such a way that the current is at a right angle phase relation to the voltage which the regulator is maintaining. This last arrangement is favored for large hydroelectric plants having individual exciters, as the individual regulator may be mounted near each exciter.

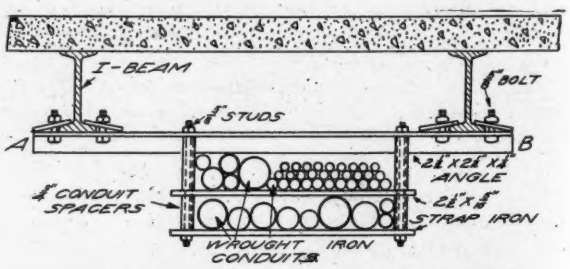
Stops may be provided on regulators to limit the field current of an alternator and this is always done when regulator is used with a synchronous condenser, keeping the voltage of the receiving and constant up to the limit of output, which is determined by a limiting field current.

Regulators for large plants are provided with accessories, such as over-voltage relays and over-current relays, which cut in an extra block of resistance in the exciter field, so that in case of over-speed on the generators or relay contacts sticking, unduly high voltage will be prevented, and in case of short-circuit the action is to prevent over-excitation of the fields.

Supporting a Multiple-Conduit Run

By George H. Drone

THE construction of a rack for carrying conduits arranged in several layers, which has been used in a number of important installations in industrial plants, is shown by the accompanying illustration. Only mild-steel members are used. Hence, the rack is absolutely fire-proof. While a 2½ by 2½ by ¼-in. angle



SHOWING A SATISFACTORY METHOD OF SUPPORTING A MULTIPLE CONDUIT RUN

is applied for the main supporting member, AB, a lighter or heavier section may be utilized, depending upon the distance between supports and on the number of conduits in the multiple run. The sizes of the bolts, straps and conduit spacers which are installed should also be determined by the size and number of conduits to be supported. Usually it is not desirable to employ any stud or bolt of a diameter smaller than ⅝ in., because smaller bolts and studs can be easily twisted in two by the wiremen.

Hoisting Problem

By Fred C. DeWeese

QUITE FREQUENTLY, the man in charge of hoisting machinery is called upon for information relative to the horsepower, per cent of incline, speed, etc., of the apparatus in his care. In many cases, the demand for coal, or whatever he may be handling is greater than the capacity for which the hoist was originally designed, and it becomes necessary to determine whether the motor or engine has sufficient power to allow for an increase in speed. This may be accomplished by changing the ratio of gearing, size of pulleys, or by enlarging the drum, whichever is the better and cheaper way.

For the benefit of the man who is called upon for such information, I have worked out the following problem. It is a specific case and the figures are based upon an outfit of which I once had charge. The problem,

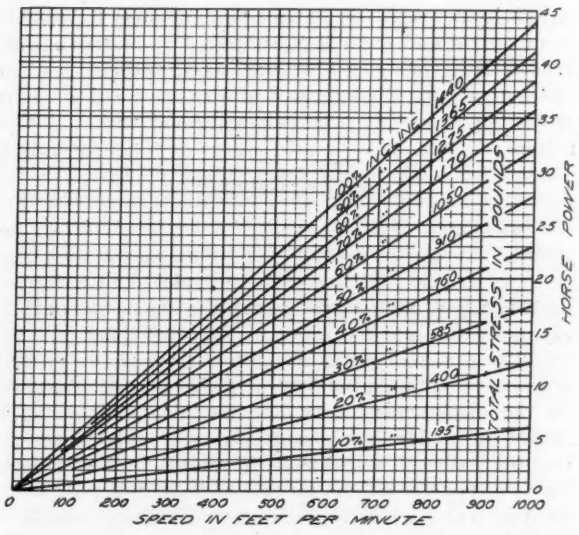


CHART SHOWING HORSEPOWER REQUIRED AND CABLE STRESS FOR HOISTING A LOAD OF 2000 LB. UP VARIOUS INCLINES

as will be seen, is very simple and no knowledge of mathematics beyond decimal fractions is required in its solution.

Example:

What will be the horsepower required at the drum, in hoisting a car of coal up a 10 per cent grade, the car weighing 140,000 lb.?

Starting at the motor, number the pairs of gears 1, 2 and 3 respectively. Ratio of No. 1—1:3.5, No. 2—1:6.14, No. 3—1:5 and speed of motor 700 r.p.m. at full load.

The diameter of the drum is 24½ in. with a ⅞-in. steel cable.

$$24.5 + 0.875 = 25.375 \text{ in.}$$

Weight on the cable (making no allowance for friction) equals

$$140{,}000 \times \frac{10}{100} = 14{,}000 \text{ lb.}$$

the 10 being the vertical lift, and the 100 being the horizontal distance, both in feet. Speed of drum equals 6.44 r.p.m. As the cable drags on the ties, we will assume the friction of cable plus the rolling friction of car to be 2000 lb. Then the total strain in cable at the drum is 14,000 + 2000 = 16,000 lb.

Beginning at the drum and working back to the motor, the torque at the drum is:

$$\frac{12.6875}{12} \times 16{,}000 = 16{,}917 \text{ ft. lb.}$$

Torque No. 3 shaft equals $16{,}917 \times 1/5 = 3383$ ft. lb.

Torque No. 2 shaft equals $3383 \times 1/6.14 = 551$ ft. lb.

Torque motor shaft equals $551 \times 1/3.5 = 157$ ft. lb.

Horsepower at motor (assuming 100 per cent efficiency) equals:

$$\frac{6.28 \times 157 \times 700}{33{,}000} = 20.91$$

Horsepower at the drum equals:

$$\frac{6.28 \times 16{,}917 \times 6.44}{33{,}000} = 20.75$$

The slight difference being due to the decimals not being carried out farther.

Assuming the motor to have an efficiency of 90 per cent, and operating at 80 per cent power factor, taking 75 amp. at 220 v., the electrical input will be

$$220 \times 1.73 \times 0.8 \times 75 = 22{,}836 \text{ watts}$$

$$\frac{22{,}836}{746} = 30.61 \text{ hp.}$$

and the output will equal

$$30.61 \times 0.9 = 27.55 \text{ hp.}$$

The efficiency of the gear train equals

$$\frac{20.75}{27.55} \times 100 = 75.32 \text{ per cent}$$

and the overall efficiency equals 68 per cent.

In case of a new installation the data here as worked out will assist materially in determining the size and ratio of gearing, size of motor, drum, etc. It is also an easy matter to calculate the power to be developed by each pair of gears.

The accompanying chart shows the horsepower required, and the stress in cable, for a load of 2000 lb. on inclines which are ordinarily met with in practice.

To use the chart, start from the bottom at the required speed, read vertically upward to the per cent of incline, thence to the right-hand margin for horsepower. Together with the per cent of incline will be found the total working stress on the cable, in pounds.

In the construction of this chart, an allowance of 2 per cent has been made for rolling friction.

Acknowledgment

In the Sept. 1 issue, on page 851, appears an article entitled Troubles with an Absorption System which was reprinted from a recent issue of Refrigerating World. By an oversight of the printer a line giving credit to the Refrigerating World was omitted. We therefore take this method of acknowledging credit for the article.

Hazards in Gas Welding and Cutting

PREPARED BY THE ENGINEERING DEPARTMENT OF THE NATIONAL SAFETY COUNCIL

TO UNDERSTAND the hazards, and precautions to be taken in the safe handling of gas welding and cutting apparatus, it seems advisable to consider briefly the principal characteristics of the materials used.

Electrolytic oxygen is prepared by passing an electric current through water in a vessel called a cell which is so arranged that the oxygen is kept separate from the hydrogen. Oxygen is furnished in steel cylinders under a pressure of about 2000 lb. per sq. in.

Pure oxygen will not burn or explode; it helps other substances to burn, and with hydrogen, acetylene and other combustible gases it forms an explosive mixture. Disastrous explosions have occurred when oxygen has not been properly separated from hydrogen during manufacture, or when other combustible gases have become mixed with it.

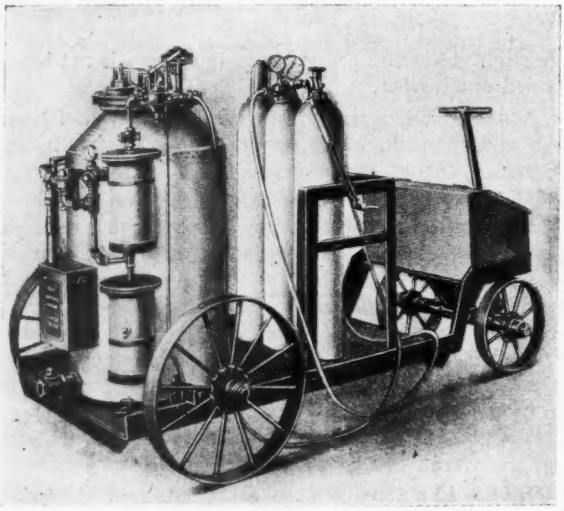


FIG. 1. PORTABLE OUTFIT COMPRISING ACETYLENE GENERATOR AND OXYGEN TANKS

Hydrogen for blowpipe use is usually made simultaneously with oxygen by the electrolytic process, being carefully separated from the oxygen by the producing cell. Hydrogen is furnished in cylinders under a pressure of 1800 lb. per sq. in. It ignites when in contact with a spark or flame and, with oxygen or air, forms an explosive mixture.

Carbo-hydrogen gas is composed of about 83 per cent of hydrogen, the rest being mainly hydro-carbon gases. It is stored in cylinders containing 100 and 200 cu. ft. of gas, under a pressure of 1800 lb. per sq. in. Blau gas, thermoline, pintsch gas and other gases used with oxygen in the blowpipe or torch are very combustible, hence are easily ignited, and with oxygen or air may form an explosive mixture.

Acetylene is made by treating calcium carbide with water in a properly designed generator. It is neither inflammable nor explosive and is sold in cans or drums. These drums are sometimes damaged in handling, and if water comes in contact with the carbide there is danger of ignition and explosion. If a metal tool is used to open the drums, a wooden mallet and not an iron hammer should be employed. Carbide drums should be stored in a well ventilated dry place.

Acetylene (C_2H_2) consists of approximately 92 per cent by weight of carbon and 8 per cent by weight of hydrogen in combination. It is one of the few endothermic gases, that is, gives up heat when it splits up into its constituents—carbon and hydrogen—in the welding flame, thus adding to the heat produced in combustion. This gas is capable of producing a higher flame temperature (approximately 6000 deg. F.) than any other known gas. Acetylene like other combustible gases ignites readily, and also forms an explosive mixture with air or oxygen.

Acetylene should never be used at a pressure exceeding 15 lb. per sq. in., as above that pressure it is liable to dissociate and explode if subjected to heat or shock. It may, however, be safely stored at pressures exceeding 15 lb. per sq. in. if compressed into an approved cylinder containing a porous substance saturated with a liquid solvent.

ACETYLENE GENERATORS

THESE ARE of three types, known as "carbide to water," "water to carbide" and "displacement" generators. In the first, the carbide is placed in a hopper in the upper part of the generator from which it is gradually fed into the water in the lower part. In the water to carbide type of generator, a regulated amount of water is allowed to flow into the carbide chamber. In the displacement type, the carbide is placed in a basket or holder which is dipped at regular intervals into the water. The "carbide to water" type of generator is in general use, as by this method it is possible to produce cool, washed gas in large volume, which is essential for welding purposes.

Generators are spoken of as medium or low pressure, depending upon the pressure under which the gas is formed. A medium pressure generator is one in which the maximum pressure in the generating chamber does not exceed 15 lb. per sq. in., under any conditions. In the low pressure type the pressure never exceeds 1 lb. per sq. in. and is usually only a few ounces.

Portable generators (Fig. 1), usually on wheeled trucks, are designed primarily for outside use, and should not be employed in shops. They should not be used within 10 ft. of combustible material (except the floor) and should be cleaned and recharged outside of buildings. When charged, they should not be moved by crane or derrick. The manufacturer's instructions should be followed explicitly when handling generators.

Many accidents have been caused by using home-made generators, and these should not be used. It is better to pay a higher first cost and get the benefit of the experience of reliable manufacturers and trained designers. The regulations of the National Board of Fire Underwriters (1919 edition) should be followed in the installation of all generator equipment and only

apparatus approved by Underwriters' Laboratories should be used.

Many accidents have happened while generators were being cleaned. This should preferably be done only by daylight. When it is necessary to do it by artificial light an incandescent lamp in a vapor-proof globe with a guard to prevent breakage should be used. Extension cord should never be used as a spark might be caused by a defective cord. Matches or an open flame must never be used, as pockets of gas are liable to remain in the generator even after the pressure is all off the gage.

The following additional "Do's" and "Don'ts" should be observed in operating the generator:

Clean and charge at regular intervals.

Always flush out before recharging.

When recharging carbide to water generators, always keep the generating chamber filled with water to exclude air.

Don't put in any fresh carbide without renewing the water.

Don't use anything but steam or hot water to thaw frozen parts.

Don't test for leaks with an open flame. Use soapy water.

Don't leave the generator open to the air nor blow air through it.

Don't smoke or carry matches around the generator.

Don't make repairs until the generator is free from gas. Flood the water chamber before repairing and make sure the generator is absolutely free from all gas and carbide.

Follow the manufacturer's rules; post them conspicuously in generator room.

Never leave carbide drums open while any carbide remains in them. Don't experiment.

Cylinders

Use only cylinders which comply with the specifications of the Interstate Commerce Commission and are so marked. (See regulations of the Bureau of Explosives, September, 1918). Compressed gas cylinders must never be handled by an electric magnet. When cylinders must be handled by a crane or derrick, they should be carried in a cradle rather than a sling, and extreme care should be exercised that they are not dropped.

Empty cylinders should be plainly marked EMPTY with valves closed and sent to storeroom. They should be returned to the manufacturer as soon as practicable.

Acetylene Cylinders

Acetylene may be purchased in cylinders supplied to the trade in sizes containing up to 500 cu. ft., of dissolved acetylene under maximum pressure of 250 lb. at 70 deg. F. To store acetylene safely, the cylinders are packed with some porous material like asbestos, which is then soaked with a liquid solvent such as acetone. Acetylene gas is then forced into the cylinder where it is absorbed by the acetone. The solution of acetylene in acetone is non-explosive even under high pressure. Therefore, when put up in this way the gas is safe.

Acetylene cylinders should be handled carefully, as should other high-pressure containers. Knocks, falls or rough handling are liable to damage the cylinder, valve or fuse plugs, and cause leakage, and may even result in an explosion. The cylinders (unless empty) should always be stored and used in an upright position; if allowed to lie on their sides, the acetone may leak out with escaping gas. This would cause improper working of the regulators.

Acetylene cylinders should be stored in a safe, dry, well ventilated place where they will not be unduly exposed to the heat of stoves, radiators, furnaces, or the direct rays of the sun. Heat will increase the pressure, or it may melt the fusible safety plug with which all cylinders should be provided and which melts at a temperature of approximately 212 to 220 deg. F.

Every precaution should be taken to prevent leaks of gas at connections made to the cylinder valves. If a leak is discovered at a connection, always shut off the cylinder valve before tightening connection. See that gas is not leaking around cylinder valve stem; if there is a leak at this point, tighten the stuffing nut. In case of a leak developing in the cylinder, place the cylinder in the open where the gas can not escape into a confined space. Do not attempt to repair cylinder, but notify the filling station and in any case drain the cylinder of gas before shipping.

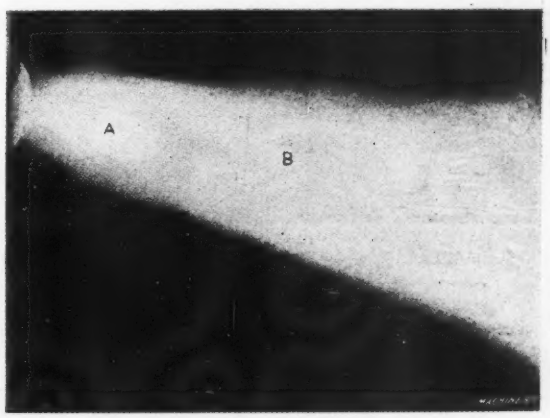


Fig. 2. Appearance of a properly adjusted oxy-acetylene welding flame

When welding or cutting is being performed in a confined space, such as the interior of a boiler, always leave the cylinders on the outside with an attendant and lead the gas in, through hose, to point where work is being done. Fire-resisting hose is advisable for such work. Leaks can usually be detected by the odor of the acetylene gas and their location can be determined by putting soapy water on the fittings and watching for bubbles.

Acetylene acts on pure copper producing under some conditions an explosive compound. For this reason no copper fittings should be used on acetylene tanks. Brass or bronze may be safely used.

Oxygen Cylinders

Oxygen is supplied to the trade in cylinders of various sizes up to 250 cu. ft. of gas under a pressure of from 1800 to 2200 lb. per sq. in. The outlet valve is protected by a cap which when the cylinder is not in

use should always be in place, screwed down against boss plate to prevent injury to the threads and plate.

Oxygen cylinders should be handled carefully, should never be dropped, and should be placed so they will not fall nor be struck by other objects. The principal hazards in the use of oxygen cylinders are caused by tampering with the fittings, and the use of grease or oil on the apparatus.

The discharge valve should be opened slowly when the cylinders are first put into use. If the high pressure is suddenly released it is liable to damage the regulator and pressure gages, which should always be employed when oxygen is discharged from a cylinder. A hammer should never be used for opening the discharge valves.

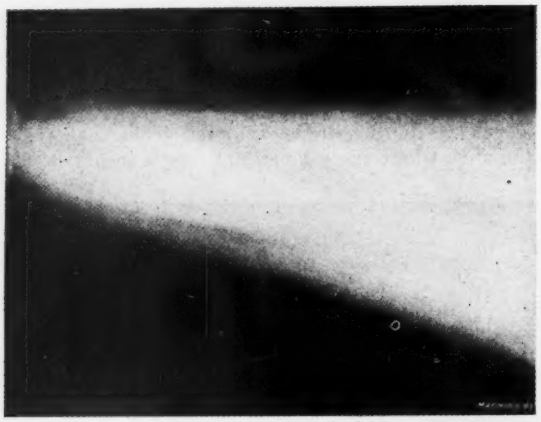


FIG. 4. APPEARANCE OF OXY-ACETYLENE FLAME WITH AN EXCESS OF ACETYLENE

Oxygen cylinders should not be stored near acetylene cylinders because of the possibility of leaks developing in acetylene cylinders with resulting possible ignition.

Where only one torch is used, the cylinders containing oxygen and the combustible gas may be conveniently mounted together on a truck. They may then be easily moved about and are also less liable to injury. In large installations the cylinders may be stored upright in a battery, with their discharge valves connected by a manifold.

When shops are piped for oxygen, care should be taken that the pipe lines are free from rust and that no grease, white lead or similar substances are used in the pipe joints.

Regulators or Reducing Valves

Regulators or reducing valves must be used on both the oxygen and the combustible gas cylinders to reduce the pressure and maintain a constant or even pressure of gas for the torches. All pressure regulators should be equipped with safety relief valves or be so designed that, should the diaphragm rupture, broken parts will not fly. Workmen should not stand in front of regulators when making adjustments, but always at the side.

High pressure gages should be provided with safety vent covers to protect the operator from broken glass in case of an internal explosion. All oxygen gages should be marked "Oxygen—use no oil."

Fatal and serious accidents have resulted when oxygen regulators have been attached to cylinders containing the combustible gas, or vice versa. To guard against such occurrence it has been customary to make connections for oxygen regulators with right-hand threads, and those for the combustible gas with left-hand threads, and also to paint the regulators different colors for the purpose of distinguishment.

When regulators are not in use, the pressure-adjusting device should always be released. Oxygen cylinder valves must never be opened until the pressure-adjusting device on the regulator is fully released.

Oxygen under pressure forms an explosive mixture with oil or grease and a serious explosion may result. No oil or grease or other lubricant of any kind should be used to lubricate a regulator or to test the gages.

The following procedure should be followed in detail when attaching regulators or reducing valves to any gas cylinders:

(a) Open the discharge valve on the cylinder slightly for an instant and then close it. Before opening discharge valve on combustible gas cylinders, see that no open flame or other source of ignition is near.

(b) Connect the regulator to the outlet valve on the cylinder. Be careful to observe whether the connection has left or right-hand threads. Never connect an oxygen regulator to a cylinder containing combustible gas or vice versa. This is highly important.

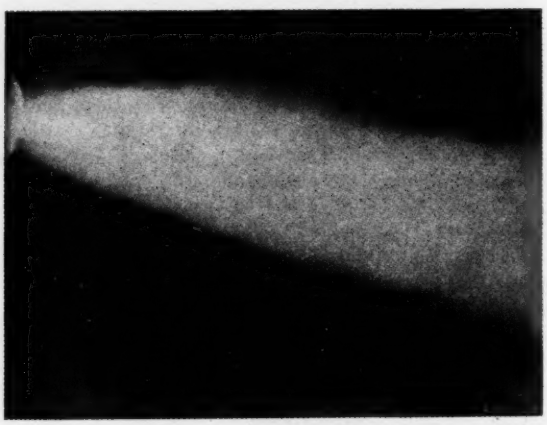


FIG. 4. APPEARANCE OF OXY-ACETYLENE FLAME WITH AN EXCESS OF OXYGEN

(c) Release the pressure-adjusting screw of the regulator to its limit.

(d) Open outlet needle valve, if one is attached to the regulator. If there is no outlet valve open valve on blowpipe.

(e) Open the discharge-valve on the cylinder very slowly. In the case of oxygen cylinders gradually open the cylinder valve to its full limit, but in the case of acetylene cylinders only open the valve one and a half turn of the valve spindle. When you open the discharge valve, stand to one side of regulator, never in front of, or back of it.

(f) Close outlet needle valve and screw in the adjusting screw on the regulator until the pressure shows about 10 lb. on the low pressure (working) gage.

(g) Note if the regulator creeps; creeping will be

indicated by the reading on the low pressure gage increasing. If there is a creep have the regulator repaired.

(h) Before releasing the pressure-adjusting screw on the regulator (except for working adjustment), always first close the cylinder valve and drain the regulator of gas.

(i) Adjust the regulators until the required working pressure is indicated on the low pressure gages.

(j) Open the outlet needle valves on the regulators (if provided) and next open the needle valves on the blowpipes and light up according to the procedure described in the instructions that are provided with welding apparatus.

Hose

The oxygen and acetylene hose should be of different color or the couplings should be stamped for identification to avoid getting the hose interchanged. Black rubber hose is now ordinarily used for acetylene and red for oxygen. They are attached to the outlet of the regulator at one end and to the welding torch at the other. A suitable clamp and fitting, not requiring the use of a gasket, should be used for making the connections to the torch and the regulator. It is important that these connections be tight.

All joints and connections in pipe lines for oxygen should be made by well fitted threads using a small amount of litharge and glycerine, or by threading and soldering, brazing or welding. No white lead, grease or other pipe fitting compounds should be used for making tight joints.

Torches and Blowpipes

Torches or blowpipes are built up of metal castings, forgings and tubing, usually brass or bronze. It is best to use only those blowpipes which have been approved by Underwriters' Laboratories.

There are two types of blowpipes in general use, known as the "injector" or low-pressure type and the "pressure" or equal-pressure type. In the "injector" blowpipe, the acetylene is drawn into the mixing chamber by the velocity of the oxygen, and may be supplied either from a low-pressure generator, a medium-pressure generator, or from cylinders; in the "pressure" blowpipe, the gases enter the blowpipe under pressure, therefore the acetylene must be supplied from cylinders, or from a medium-pressure generator.

The accompanying illustrations show the oxy-acetylene flame in its various aspects. The oxygen and acetylene from the blowpipe tip first combine in a small whitish-blue cone and form carbon monoxide and hydrogen. This cone should be sharply outlined and surrounded by an almost imperceptible pale-blue flame. In the outer blue flame, the gases combine with the oxygen of the air and form carbon dioxide and water vapor. It is advisable that the room where welding is done be well ventilated. Strong drafts, however, should be avoided, or the welded work is liable to crack.

A common occurrence with blowpipes is that of back-firing a combustion of gases which takes place inside the blowpipe itself. The principal causes of back-firing are improper gas pressure and the clogging up of the tip by particles of dirt or oxide. When a back-fire occurs, both gases should be immediately shut off—first the oxygen, then the acetylene. If the blowpipe is overheated due to the back-fire, cool it in a bucket of water. Before lighting up again, see that the blowpipe is cool, and first blow a little oxygen through it to remove any carbon that may have accumulated owing to back-fire.

When welding on heavy work, blowpipes may become over-heated from radiated heat and it is advisable to cool them periodically in a bucket of water. The combustible gas should be shut off before plunging the blowpipe into water, though the oxygen should be allowed to bubble through slowly to keep water from inside of blowpipe.

The procedure to be followed in lighting blowpipes varies with the design and style of the blowpipe employed. The instructions for lighting furnished by the manufacturers should be minutely followed. Small, handy lighters may easily be obtained for lighting blowpipes and are convenient and more safe than matches. Never put down a blowpipe until the gases have been completely shut off.

A fire extinguisher should be near at hand where welding is being done. It is advisable to carry one as regular equipment on all portable welding apparatus.

Eye Protection and Clothing

An important hazard in the use of the blowpipe or torch is that of injury to the eyes, by the heat and glare from the work and by particles of hot metal that fly up from the weld. Properly colored lenses fitted in goggles will furnish complete protection to the eyes.

Goggle frames preferably should be of a material which is a non-conductor of heat. If metal frames are used they should be padded. The frame should permit free air circulation, therefore have wire mesh or vent holes in the cups.

When working on heavy work for long periods of time, operators may be supplied with fire-proofed gauntlet gloves and aprons, as a protection against the radiated heat. Woolen clothing is preferable to cotton because it is not so easily ignited and protects the workmen from changes in temperature. It is advisable, however, that the outer clothing (jumper or over-alls) worn by all operators of a blowpipe or torch be fire-proofed. Fireproofing may be cheaply and easily done.

U. S. Civil Service Commission announces examinations, Sept. 21, for the following positions: Engineering Draftsman, $1200-$3000; Topographic Draftsman, $1200-$3000. Vacancies in the Reclamation Service at salaries ranging from $1200 to $3000 a year, and in positions requiring similar qualifications, at these or higher or lower salaries, will be filled from these examinations. Appointees at annual compensation of $2500 or less, whose services are satisfactory, may be allowed the increase granted by Congress of $20 a month. Competitors will be rated on drafting, education and experience, and must have reached their twenty-second birthday on the date of examination. Age limits do not apply to persons entitled to preference because of military or naval service. Apply for Form 1312, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.

Hydroelectric Power in Ontario

ALTHOUGH OVER 1,000,000 HP. ARE UTILIZED PLANS HAVE ALREADY BEEN MADE FOR ADDITIONAL DEVELOPMENTS. BY W. L. EDMONDS*

WHILE nature, when allocating coal fields on the North American continent, made no distribution in that part of it which is today known as the Province of Ontario, yet it subsequently made substantial compensation for its neglect in this particular by a generous bestowal of lakes and rivers from which hydroelectric energy could be developed in process of time. One has only to glance over a topographical map of the province to see how wide as well as generous this distribution is. Lakes and rivers dot and bisect its surface in every direction, and not an acre of land is beyond the potential reach of hydroelectric power.

PRINCIPAL WATER-POWER RESOURCES

JUDGED FROM the standpoint of its potential possibilities, the St. Lawrence is, of course, the most important, the waters of which, within the Province of Ontario, are capable of developing hydroelectric energy to the approximate total of 2,000,000 hp. Next in order of importance is the Niagara River, with its inflow from Lake Erie of 210,000 cu. ft. of water per second, from which the potential possibilities on the Canadian side are 1,500,000 hp. of hydroelectric energy. The Ottawa River, which in itself is capable, between Lake Temiskaming and Carillon, of developing 600,000 hp., and with its tributaries 688,000 hp., is third in order of importance. The estimate of the Dominion Conservation Commission of a minimum aggregate capacity of 665,000 hp. for the rivers of Ontario entering St. James Bay would rank that district fourth in order of importance. Then there follows that part of the Montreal River within the Province with water powers capable of developing 250,000 hp.; rivers tributary to Lake Superior, capable of developing 195,000 hp.; rivers tributary to Lake Huron, with a potential capacity of 166,000 hp.; rivers on the Hudson Bay slope, 250,000 hp.; three undeveloped sites on the French River each capable, with storage at Lake Nipissing, of developing 10,000 hp.; and the Trent River, with its tributaries, 75,000 hp.

HYDROELECTRIC POWER INSTALLED

DURING THE past decade or two, the Province of Ontario has probably exceeded all other areas in the world of similar size in respect to its development of hydroelectric energy. Thirty years ago, all that the Dominion as a whole could boast of possessing in hydroelectric power installed was 4500 hp. Today, or more accurately speaking, up to the beginning of January, 1920, according to figures compiled by the Bureau of Statistics at Ottawa, the Province of Ontario has plants installed capable of developing 1,015,726 hp. of hydroelectric energy, or rather more than 42 per cent of the total for the Dominion as a whole. Compared with population, it means 369 hp. for every 1000 inhabitants of the Province.

But the most important feature in connection with this 1,015,726 hp. is that it is approximately equal to 20,000,000 tons of coal. As the plants under actual construction will bring the installed hydroelectric power up to about 1,500,000 hp, it follows, without even taking into account future new enterprises, that the Province of Ontario will within the next year or two have in operation hydroelectric power equal to 30,000,000 tons of coal, or about one-third in excess of the average quantity of the latter imported annually by the Dominion during the last few years.

PRINCIPAL HYDRO-DEVELOPMENTS

THE SCENE of the principal hydroelectric development and one which is likely to maintain the premier position for many years to come, is the Niagara River district. In the immediate vicinity of the falls, on the Canadian side of the river, there are in continuous operation three hydroelectric plants, the aggregate output of which is about 450,000 hp. When the Chippewa to Queenston canal is completed, which is expected to be some time during 1921 and the power plant near the latter town is brought into operation with its normal capacity of generating 300,000 hp. of hydroelectric energy, the grand total will be about 750,000 hp., or an increase of two-thirds over the present supply. The ultimate capacity of the Queenston plant is expected to be about 650,000 hp. The total available potential horsepower on the Canadian side of the Niagara is conservatively estimated at 1,500,000 hp., thus allowing room for considerable further development even after the Chippewa-Queenston plant is developing its proposed maximum. At Decew Falls, on the Niagara escarpment, is a plant of nearly 60,000 hp. capacity distributing electric energy to Hamilton, Brantford and other towns in the western part of the Province. The development of hydroelectric power on the Niagara River proper had its advent in a small way in 1895.

On the Trent, which is the most important river emptying into Lake Ontario, there is, according to the latest available figures, 45,000 hp. being developed between Balsam Lake, the highest point on the system, and the town of Trenton, its outlet.

In the upper part of the Ottawa valley there are a number of hydroelectric plants of more or less importance in operation, the most important of which supplies energy to Cobalt and the mines in that part of the Province. On the Ottawa River proper, the most important development is at the Chaudiers Falls, where 36,000 hp. of hydroelectric energy is developed and distributed in the City of Ottawa for power, electric light and street railway purposes.

On the tributaries of the Province running into Lake Superior are being developed, according to the latest available figures, about 25,000 hp., the larger part of which is utilized by the twin cities of Port Arthur and Fort William for various purposes, while the balance is distributed to the plant of the Algoma Steel Co., the mines in the Michipicoten district, and other industrial concerns.

When the plant now in course of construction on the Nipigon River by the Provincial Hydroelectric Commis-

* Of the Canadian Bureau of Information, New York City.

sion is completed, providing as it does for a present supply of 25,000 hp. and an ultimate of 75,000 hp., the developed power on the tributaries of Lake Superior will at least be doubled in capacity. The Nipigon is the largest of the rivers emptying into Lake Superior, and being 40 miles long with a drop in that distance of 255 ft., and Lake Nipigon with its 1500 sq. mi., as a source of supply, has obviously great potential possibilities in respect to the development of hydroelectric energy.

The most important individual developer and distributor of hydroelectric energy in Ontario is the Provincial Hydroelectric Commission. This commission came into existence in June, 1906, the members of which are appointed by the Provincial Government but it works in connection with the various municipalities to whom electric energy is supplied. The bonds which the Commission from time to time issues for the purpose of financing its various enterprises are guaranteed by the municipalities concerned and endorsed by the Government.

The Commission began the construction of transmission lines in 1909, several hundred miles of which were completed by the end of the following year. The original supply of power was obtained from the Ontario Power Co., one of the Niagara concerns, with whom a 30 yr. contract was made.

By August, 1914, the Commission was developing and distributing 49,000 hp. From that time onward, owing to the demand for power from industries engaged in the manufacture of munitions and other war material, there was a steady and marked increase in the development of power, the total reaching 151,000 hp. by November, 1918.

Today the Hydroelectric Commission has 12 distinct systems developing power at various points in the Province from the Niagara River on the south to Thunder Bay in the north, and from the Ottawa River in the east to the Detroit River in the west, while the total amount of power being distributed is 292,290 hp., serving a population of 1,419,220, out of a total of 2,550,453. The number of municipalities being served at the end of 1919 were 181, of which 121 were within the territory of the Niagara system.

The present capacity of the 12 systems being operated by the Hydroelectric Power Commission is 400,000 hp., with an ultimate of 1,950,000 or almost double the total amount of hydroelectric energy now under development in the Province by public and private enterprise.

The probable next important development in respect to the utilization of hydro power in Ontario will be in connection with the contemplated expansion of the electric radial railway systems of the Province and the electrification of at least some of the steam railway lines. Experts estimate that to electrify all the steam railways within the Province energy to the amount of 125,000 hp. would be required.

Hydroelectric energy for domestic heating purposes is used only in a supplementary way, and for two particular reasons, the first being inadequacy of supply owing to the demand for power and lighting purposes and the second that coal is still relatively cheaper. When the fact is taken into account that even if all the electric energy now being developed in the Dominion could be utilized for heating purposes in the Province of Ontario alone, it would only be sufficient to replace fuel for one-half of its population, it naturally follows that many years must elapse before the homes of the Province reach the same measure of independence in respect to coal as is now enjoyed by its factories.

An Emergency Well Met

WITH TWO BOILERS OUT OF COMMISSION AND THE LAST ONE IN DANGER, MURDOCK MEETS THE SITUATION. BY A. W. KRAMER

LIEUTENANT ROBERT MURDOCK, first assistant engineer on the U. S. S. Western Star, looked decidedly worried as he hurriedly made his way to the chief engineer's cabin.

"Well, Murdock, what's wrong now?" inquired the chief as the young assistant seated himself on the edge of his desk. "I can see that there is something wrong by your cheerful countenance. What is it now—bottom drop out?"

Murdock smiled in spite of himself.

"Everything's wrong, chief," he replied, despondently. "Ever since we left Gibraltar a week ago, things have been going wrong. First, No. 2 boiler went out of commission; then, half-way up the Mediterranean, the steering engine blew a cylinder head off. Now, just as we have completed the repairs on the steering engine, the water tender informs me that No. 3 boiler is leaking; and, what's worse, the leak is in exactly the same place as the leak which put No. 2 out of service—just between the two front cross boxes where the ends are welded in."

"Damn!" exploded the chief. "This is a hoodoo ship, Murdock—full of junk. They send us out on a scow with a concrete mixer for an engine, a teapot for a boiler, and expect us to run it. Believe me, if those birds over there in Washington knew the condition of these tubs, we would all be awarded D. S. C's. for bravery—and we would deserve 'em.

"But how about this leak," he continued, cooling down, "is it serious enough to have to close down the boiler?"

"Well, not at present," explained Murdock, amused at the old chief's apparent rage. The water tender reported it 15 min. ago and I went below to look at it immediately. It's not so serious just yet, but judging from the way No. 2 behaved, I am afraid the trouble will become worse. You see, we have been forcing the boilers somewhat on account of No. 2 being out of service. That, no doubt, aggravated the trouble. I have cut the steam pressure down to 192 lb., but I don't think that will relieve matters much.

"No, I'm afraid not," agreed the chief. "However, keep her in service as long as possible. This is Sunday and we ought to reach Triest sometime Tuesday afternoon. We are about half-way up the Adriatic now."

"We are not making very much headway," remarked Murdock.

"No, I realize that, but the captain told me this morning that if we continue to do 9.5 knots, we will

reach Triest at about 6 o'clock Tuesday afternoon. So, if we can manage to keep No. 2 boiler going for another 36 hr. there will be no cause for worry. If necessary, we can make the last few miles on one boiler. At Triest, the boilers will be repaired."

* * * *

Murdock's fears regarding the new boiler leak were realized only too soon. By 5 o'clock that afternoon, it had become so serious that there was no alternative but to shut down the boiler. The leak was in the most inaccessible place possible—just at the end of the left crossbox where the two front crossboxes butted together. Only a half inch of space existed between them, so welding with the boxes in place was out of the question. The only solution to the problem was to cut off the downcomer nipples, remove the crossbox, and after electrically welding the end, replace it. As this would require approximately two weeks, repairing at sea was not feasible.

Bound for Triest, Austria, with a cargo of flour, they were about half-way up the Adriatic Sea. It was rather dangerous for although the war was over, the Adriatic had been thoroughly mined by both the Austrians and the Italians, and but for a narrow, tortuous channel through which the ship was being piloted by an Italian naval officer, was impassable. This channel was scarcely 3 mi. wide and any attempt to navigate it without the services of an expert pilot would have spelled almost certain destruction.

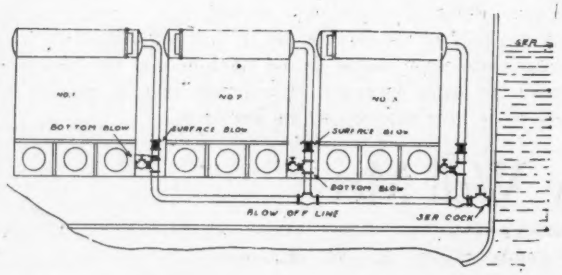


FIG. 1. ARRANGEMENT OF BOILERS AND BLOWOFF LINE ABOARD U. S. S. WESTERN STAR

With two of the three boilers out of service the speed of the ship was reduced to 8 knots, hence, even under the best of conditions they could not expect to reach port before Wednesday. The weather too, began to show indications of a gale; this would further retard their progress.

Up in the wardroom that evening, the captain, the chief engineer, and the first assistant discussed the situation.

"As long as that boiler of yours holds out, chief, there is no danger," remarked the captain. "You had better watch it with about the same care that you would a lighted cigar in a powder magazine—treat it gently; pet it; feed it sugar—do anything. As long as we can keep the ship under way, we can keep to our course; but if we should fail in the first respect, we would soon be blown out of our course into the mine fields on either side of the channel—and then, good night, Western Star!"

"We'll do our utmost, captain," promised the chief, "I'll have my best men on the job. They have been instructed to take no chances whatever with the boiler and to steam under reduced pressure. What is the outlook for the weather, captain?"

"Dirty weather ahead," answered the skipper. "The barometer has been falling all afternoon and by the looks of things we are in for a good blow. This is a bad piece of water when it lets loose—I have been up this way before."

"Well, gentlemen," he continued a few minutes later, "guess I'll go up to the pilot house for a while and see how the pilot is making out. Good night; keep her moving, chief."

"You can depend upon us to do that, captain," responded the chief. "Good night."

* * * *

At 4 o'clock the following morning the chief went below to make certain that all was well in the fire-room. He found everything in good shape. Collins, the water tender on watch, was an excellent man and knew his business.

"How is she running, Collins?" asked the chief.

"Pretty good, sir," replied the water tender.

"How much pressure are you carrying?"

"One hundred ninety, sir, that's what I have been carrying the entire watch. I imagine she needs blowing down a bit—my oil pressure is a trifle high for the steam pressure we are maintaining.

"Very well, open up the bottom blow for a minute, Collins. By the way, is that sea valve still open?"

"Yes, sir," replied the water tender, as he started to open the valve, "we can't close the valve; Mr. Murdock says we will not be able to overhaul it until we get into drydock."

The roar of the steam as Collins opened the bottom blow valve, interrupted the conversation. For two minutes the two men watched the water column; then, as the water dropped a trifle, the chief motioned to the water tender to close the valve. "That's enough, Collins," he cried, "close her up."

The man complied instantly and had turned the valve wheel through two complete turns when it abruptly resisted all his further efforts to close it. With his entire strength applied to the wheel, the water tender tugged laboriously for a half minute; then as the chief came over, they both applied their efforts—but with no success. The valve was stuck open—nothing could move it.

"There must be something in it," cried the chief. "Open it up wide again and then try to close it."

This operation also proved unsuccessful and as the seriousness of the situation flashed through his mind, his composure left him.

And well it might! Here was his last remaining boiler with both blow valve and seacock stuck wide open, rapidly blowing all its water overboard. The accompanying sketch (Fig. 1) will serve to illustrate the situation. Both the bottom and surface blow from each boiler was connected to the common blow line which was located in front of the boilers below the floor plates. This line was of copper about 2 in. in diameter and was fitted with a gate valve at the "skin of the ship." Ordinarily, this seacock, as it is termed, should be closed; but as Collins had said, due apparently to an obstruction or some other defect, the valve could not be closed and in consequence of its position at the "skin of the ship" could not be repaired without going into drydock.

Boilers Nos. 2 and 3 were out of service as explained before. Now, with the bottom blow valve on boiler No. 1 wide open, there was no possible way of preventing the boiler from blowing down completely. This would take about a half hour, and the ship then, being deprived of her means of locomotion, would soon drift into the mine infested waters. Indeed, the chief engineer had good reason for losing his customary composure. How could he shut the valve!

"Get a wrench, quick," he yelled to the water tender. "We've got to close this valve! Send up for Murdock—get him down here immediately."

With hammers, wrenches and other tools, the chief and Collins worked assiduously but without avail, and when Murdock arrived a few minutes later, the valve stem had been bent in the attempt to close the valve, but it obstinately remained open.

"We are in for it now, Murdock," yelled the chief. "Look at that! Both valves wide open and the water going out like blazes."

The first assistant took in the situation at a glance. He had spent an hour two days before in an attempt to close the disabled seacock—he knew beyond a doubt that that was open.

"Confound it," he exclaimed, examining the blow valve. "You said it, chief, when you called this ship a hoodoo yesterday. She's a jinx." He pondered for

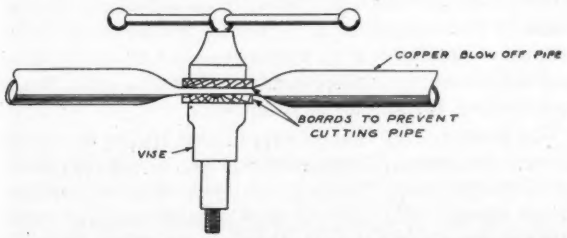


FIG. 2. SHOWING METHOD OF COLLAPSING COPPER PIPE

a moment, regarding the polished blow line intently.

"Did you—," he began to address the water tender, but he stopped short and suddenly wheeled around. "I've got it," he cried.

"Got what?" growled the chief.

Murdock ignored the chief's question. "Open up these floor plates," he commanded to two of the firemen. "Uncover the blow line. And you, Collins," he continued to the water tender, "go up to the store room and bring down that large vise. Hurry!"

The old chief was puzzled and regarded these commands with amazement. "A vise? What in thunder do you want with a vise?" he demanded.

Murdock laughed. "Just stick around and watch me, chief, I'll show you in a moment—you know, chief, you may not believe it, but it sometimes happens that I show signs of intelligence. This is one of those times. I have an idea!"

"So have I," retorted the chief, with affected disgust, "I've got an idea that you are mentally unstable."

"Wait 'till I get a couple of boards and you will see me perform," said Murdock. "I will be back in a moment."

He returned in the course of a minute with two ½-in. boards, each about a foot long. The fireman had in the meantime removed the floor plates in front of the boiler and Collins had returned with a medium sized vise. Jumping down into the bilges about 4 ft. below the floor plates, he directed Collins to hand the vise down.

"Now, Collins," he instructed, "hold one of these boards against each side of this blowoff pipe."

This done, Murdock placed the vise so that the jaws clamped the boards and the blowoff pipe between them and began to screw down on the vise. Slowly the copper tube collapsed.

And then the chief perceived what the idea was. "By George!" he exclaimed. "Now I get you, Murdock. Here, let me help you."

He was not slow in lending his assistance. In less than a half minute, the soft copper pipe had been sufficiently flattened between the powerful jaws of the vise to prevent much water from passing. Murdock's scheme was a success. The blowoff line was closed.

The chief was elated. No one appreciated the success of the operation more than he. "Good work, Murdock," he complimented, shaking his assistant by the hand. "How did you think of it? That worked like a charm. In the 30 yr. of my experience at sea, I never encountered a case of this kind before and would never have thought of collapsing that pipe if you had not done so. You saved the ship, my boy, and incidentally, our reputations."

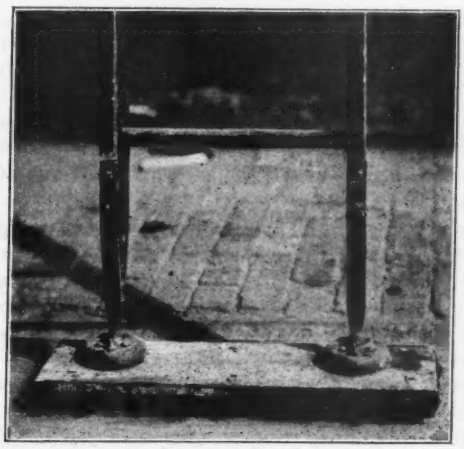
"And spoiled a perfectly good copper blowoff pipe," added Murdock, looking at the flattened pipe.

"D—n the blowoff pipe," roared the chief.

Something New in Non-Skid Ladders

LADDERS equipped with safety non-slip mats, as illustrated below, are being used extensively in the works of the Eastman Kodak Co., Rochester, N. Y., a member of the National Safety Council.

W. T. Barrett of the Eastman Co., who designed the appliance, writes that it is giving complete satisfaction.



SIMPLE DEVICE TO REDUCE LADDER ACCIDENTS

The mat is attached to the ladder by means of ball and socket joints which permit the ladder to stand at any angle while the mat rests flat on the floor.—National Safety News.

THE EXPERIENCE of others, supplemented by your own, is your best guide.

Oil Burning*

THE EQUIPMENT REQUIRED AND COMBUSTION RESULTS. BY F. G. HUMMEL

WITH the unprecedented coal situation of the last several months, more and more plants throughout the country have become interested in the matter of oil burning equipment, principally because of the shortage of coal and therefore the threatened necessity of shutting down plants, and secondly, because of the increasing cost of coal per ton.

When oil burning first began to be commercially used, in this section of the country, it was called "fuel oil," and came principally from the fields around Beaumont, Texas. This was a light oil of specific gravity running from 25 to 28 deg. Beaumé, and was easily handled, pumped and burned, and required little or no heating before being fed to the burners. The name fuel oil was given this and still means that oil which has not been topped and which has not been mixed with any other oil.

The Mexican oil which is put on the market extensively at the present time is a heavy oil with high viscosity and rather low gravity. Specific gravity ranging from 11.6 to a maximum of approximately 18 deg. Beaumé. This oil is in some cases oil which has been topped, the lighter oil having been taken from it and the residue mixed with a low grade of lighter oil, so as to reduce its viscosity and raise its flash point, because the crude petroleum has a low flash point ranging as low as 100 to 125 deg. F., whereas the Fire Underwriters require a minimum of 150 deg., closed cup, which corresponds to about 175 deg. open cup method of testing.

This heavy grade of Mexican crude oil is just as desirable for commercial use as the lighter grade of oil. The heavy grade running lower in B.t.u. per pound than the lighter oil, but about the same per gallon. For successful handling of the Mexican oil, it is absolutely essential to raise its temperature, for, if this is not done, it cannot be successfully pumped, and before being fed to the burners, the temperature must be again raised, so as to reduce its viscosity to such an extent that it can be thoroughly atomized.

The temperature at which this oil should be burned varies with the different types of oil on the market and with the conditions of service, and can be arrived at best by trial.

There are sets of curves that have been made up and called temperature viscosity curves from which one may obtain the best temperature at which to burn this oil. These curves are made up showing the different kinds of oil as supplied by the several companies, giving as abscissae, the viscosity in degrees Engler and as ordinates, the temperature in degrees Fahrenheit. Practice has shown that the viscosity of oil should be reduced to between 8 and 12 deg. Engler. The viscosity in all cases meaning in simple language, the resistance that the oil offers to flow.

Though oil burning in general and oil burning installation is a comparatively simple matter, still experimenting with it is costly, especially in the way of using so-called homemade apparatus and homemade burners, though, in some cases, plants have rigged up complete oil burning systems very successfully.

In many more cases, such plants use an abnormal amount of oil and the whole system is wasteful. There are a few fundamental principles to be considered and unless these are taken into account, efficient burning of oil cannot be accomplished.

Complete atomization of the oil must be accomplished either before the oil leaves the burner or immediately upon leaving it. The oil should not issue from the burner in a gaseous state, because if this is the case, complete combustion of the carbon in the oil will not take place. It must be broken up into fine particles in a sort of a spray, either in the shape of a cone or flat.

The air supply must be sufficient and must be so controlled as to be brought into contact with the atomized oil in such a way that it will mix completely with all the particles and at such velocity that it will aid in the breaking up of such particles which have not been completely atomized by the burner itself, and must be supplied at the proper time, so that the combustion itself will not be delayed. The speed at which combustion takes place has much to do with the efficiency of the boiler. This speed can partially be determined by looking at the flame; a very long flame representing slow and sometimes incomplete combustion and a short flame representing instantaneous combustion.

In practice, air that is supplied is always in excess of that theoretically required, this excess running from 15 to 20 per cent. In order to meet this requirement of air supply, a system of checker work is used which allows the air to come through small air passages in fire brick of furnace floor.

Combustion space must be large enough to allow combustion to take place thoroughly in the furnace, and before the products of combustion have a chance to come into contact with the boiler heating surface. If the products of combustion are cooled down before complete combustion has taken place, smoke will be formed and in most cases complete combustion will never occur.

The velocity of the gases through the boiler has nothing to do with the combustion in the furnace proper, as the velocity will depend upon the rate of driving, the openings through the boiler remaining the same. The higher the rate of driving the greater will be the volume of gases and therefore the greater will be the velocity of the gases passing through the boiler. Therefore, for high rates of driving, it is necessary to have much more combustion space than is necessary for low rates, because if this combustion space is not available, the combustion of gases will not be completed in the boiler itself, but may be compelled later by air supply through a leaky setting in the boiler. In this case, of course, secondary combustion is obtained which is not desirable.

The arrangement and spacing of the burners must be so as to make use of the entire furnace and entirely to cover the heating surface. If this is not correct, there will be undue strain on the different parts of the boiler

* From paper read at meeting of Louisiana Ice Manufacturing Association.

which will cause leaky tubes and rapid deterioration of boiler itself.

Clean oil is essential for successful operation of the burner, as particles of dirt and other foreign matter are liable to lodge in the burner slots, thereby closing them up and throwing the flame to one side or the other or perhaps concentrating the flame on one part of the boiler.

The oil pressure at burner must be steady, otherwise the flame will pulsate, due to the varying amounts of oil being sent through the burner. And with this condition arising, air will not come into contact with the oil properly and complete combustion will not take place. Unsteady pressure will not only cause pulsation but will cause smoke, which often cannot be cleared up in any other manner than by steadying the oil pressure.

With the above fundamental principles to work on, oil burning installations which meet these principles will give satisfaction and will be economical. The installations themselves may differ widely in so far as the pumping equipment is concerned, and the type of heating apparatus, and the type of burner, and to a certain extent the type of furnace; but in all cases the principles must be met.

As stated before, with the so-called fuel oil, it is in many cases not necessary to heat this oil at all, but in the case of Mexican oils, the heating is absolutely essential. The pumps that may be used are either steam or air driven reciprocating duplex or simplex or motor driven rotary or triplex or steam driven rotary pumps or triplex pumps. For heavy oil it has been found that the pump that gives the best satisfaction is either the duplex reciprocating or the simplex pump. These pumps should be brass lined and should have metallic packing rings, because the soft packing rings will not give satisfaction because of the grit that is in the oil. The pumps used most extensively are ordinary boiler feed pumps which have been gone over carefully and packed with some form of metallic packing, preferably made of babbit metal.

Burners

Types of burners on the market are many and varied.

Steam or air atomizers are relatively simple in construction and each uses steam or air for atomizing. The oil to these burners must be supplied at a pressure which runs about 80 lb. There are several types of steam atomizers, namely, the inside mixing, in which the oil and steam come into contact with each other inside of the burner proper. The outside mixing type where the oil and steam come into contact entirely outside of the burner. Air can be used in place of steam but results are not generally as good. The relative merits of the two types have been widely discussed by engineers throughout the country and it is hard to say which is the best. Under this head also come the flat flame burners in which the oil and steam issuing forth send out a flat flame over the boiler surface and the round flame burner in which the steam comes into contact with the oil around it, thereby producing a round or conical flame. The gravity burner also requires steam for atomization; but in this type, the oil is fed to the burner by gravity flow, the pressure being from about 5 to 8 lb. per square inch. This is the most simple burner and gives satisfaction, though it cannot be used in cities or congested districts because its use is against the Fire Underwriters rules.

Mechanical burners are those which do not use steam for atomizing, but which have a nozzle so constructed that the oil is atomized due directly to the pressure and the construction of the tip. This type of burner gives a cone shape flame and air is admitted around it by means of an air register. This air register is constructed so that the air can be controlled directly around the corner.

Semi-mechanical burners have the tip constructed so as partly to atomize the oil, this atomization being completed by steam. A few of these types are on the market but they cannot be used either as mechanical atomizers or steam atomizers as both means are employed for the atomization of the oil.

Heaters

A properly constructed heater will make use of the exhaust steam from the pumping equipment and raise the temperature of the oil to that desired, although heaters are usually fitted with a live steam connection. The type of heater which has been found most efficient today is the film in which the oil passes usually through the sets of tubes so that heat from the steam is transmitted to a thin film of oil as it passes through the heater. Steam is usually applied on the outside of the tubes, the oil passing through the tubes proper. Cast iron bodies and tubes of wrought iron have been found to give good satisfaction, although many engineers use brass tubes. Mexican oil seems to have a deteriorating effect on brass and therefore manufacturers have gotten away from the brass oil heaters to a certain extent. Many heaters are made with simply a coil enclosed in a pipe or with straight pipes with return bends enclosed in a pipe. This type of heater gives satisfaction, but is not usually as economical as the film type of heater and requires either more heating surface or more steam, relatively. The heater should be of rugged construction and be so fitted up that it can be taken apart and parts replaced. It is not absolutely essential to have duplicate heaters as it is in the case of pumps, because in the heater there are no moving parts and therefore the life is indefinite. In case something does go wrong, a small plant can find time to repair this heater or in some cases burners can be run by merely heating the oil in the tank for the time being.

Appurtenances

Every outfit should contain a governor, an air chamber, strainers, pressure gage, thermometer on suction and discharge and the pumps should have a purge pipe connection, so that any gas formation can be relieved through this purge pipe.

The piping suitable for oil is standard black pipe. It is always well to use extra heavy pipe in the suction line, though standard black pipe will give satisfaction. The suction line from the tank for a proper installation should be run underground, laid in a wooden box and the steam pipe to heating coil and return line from burners should be run alongside of this pipe, and the box then packed with asbestos or sawdust or sand. The

steam line running along the suction will ordinarily supply enough heat to the oil so that it can be pumped satisfactorily. Some engineers prefer running a steam line directly through the suction. In this, of course, there is no heat loss due to radiation of the steam pipe and it gives satisfactory results; however, in case something happens to the steam line it is difficult to repair it and it is difficult to locate accurately just where a leak may have occurred. In this method, of course, stuffing-boxes must be installed on each end of the suction line. The expansion of steam pipe is usually taken care of by putting a slight bend in the pipe, so that it will be free to move in and out through the suction pipe and through the stuffing-box. In a long line this expansion might be considerable, but can be easily taken care of.

Furnaces

As stated before, large combustion space is desirable for any type of boiler and particularly so when it is desired to obtain high rating. The front shot burner, that is the burner firing from the front towards the rear of the boiler is used in nearly all boilers. In others it is desirable to have the burner placed so that the flame will be towards the front wall of the boiler. The back shot burner will give high efficiency and will cause little tube trouble because the flames do not impinge upon the tubes directly.

In many cases where a plant does not expect to burn oil permanently and wishes to be in readiness to change over again quickly from oil to coal burning, an arrangement can be made whereby the brick checker work before mentioned can be placed directly on the grates and the burner inserted through the front of the boiler directly over it. For low rating, this arrangement will give good results and high efficiency, depending, of course, upon the original setting of the boiler. Where the setting is low, that is, where the heating surface is less than 30 in. from the grates, it is always advisable to increase this combustion space by either lowering the grates or taking them out altogether and supporting the bricks by other means of construction.

The usual method of supporting bricks is by running pipes directly across the furnace space so that the ends of the bricks rest on these pipes. Another method used is eye beam or tee beam construction, in which the brick ends are supported by the flanges of the beams. In wide furnaces it is usually necessary to run longitudinal supporting pipes or beams because in long spans there is danger of the pipes warping or buckling and the furnace checker work will be disarranged. In constructing the furnace, it is always necessary to allow enough space underneath the checker work floor for storage of air so that resistance in passage of air will not be so great that the draft will have to be increased. It is always desirable to have as low a draft as possible and the more resistance there is in the passage of air of course the higher the draft will have to be. Due to the high temperature obtained from the combustion of oil, it is always necessary to protect any exposed portion of the boiler, which is not protected by a water leg. It is always essential to protect the blowoff connection with good grade of fire brick. The furnace should also be lined with good grade of fire brick.

Sometimes trouble is experienced in the rear of a horizontal return tubular boiler, due to the high temperature, but it can be easily remedied by using a good grade of fire brick and good grade of fire clay or high temperature cement. The furnace installation with horizontal return tubular boilers and the horizontally baffled types of water tube boilers is much the same. With the vertical baffle type of water tube boiler, other than the B. & W. and Stirling types in which the back shot burner is used, sometimes trouble is experienced due to the flame impinging directly on the tubes. Such types of boilers have in some cases been arranged with the bridge wall moved back and slanting vertical baffling put in the first pass, though other methods have been used with some success.

Tanks

The kind of tanks that have given satisfactory service are steel tanks and concrete tanks, though in some countries tanks constructed of wood have been found suitable. A tank should be designed to hold enough oil so that there will be no danger of oil supply running short, due to delayed delivery. Tank should be fitted up with connections for suction line, for oil return, for heating coil, for smothering line, for vent, for measuring apparatus which settles in bottom of the tank. In case of concrete tanks, this pitcher pump suction is usually run into a lowered portion of the tank.

The filling line should be large enough so that a tank car or tank wagon can be emptied in a short space of time. It is usually desirable to have this filling line 6 in. in diameter, even though the tank car or tank wagon connection is smaller. The suction flange should be large enough so that a foot valve on the end of the suction can be taken out through this flange. It should therefore be from 6 to 8 in. in diameter. Oil return usually runs from ½ to ¾ in. Heating coil is usually ½ to ¾ in.; vent is usually 2 in.

Operating

Operation of oil-burning equipment is comparatively simple. Oil pressure usually carried with the steam atomizing type of burner varies from 80 to 100 lb. It is sometimes desirable where there are load variations, therefore steam variations, that reducing valve be put in a steam line to the burners, so that burner operation will be uniform. The temperature for satisfactory results varies with the kind of oil. But it has been found that the most desirable temperature for the heavy grade of oil used in this territory is from 160 to 200 deg. F. The temperature in the tanks for satisfactory pump operation running from about 80 to 100 deg. If the temperature is raised much above this, there may be some trouble experienced in the burner, going out or puffing, because of the gas formation in the discharge pipe.

It is essential that any type of burner be cleaned and kept clean, the period of cleaning varying much with the grade of oil. For good operation, it is absolutely essential to control the draft by the damper and in all cases it is desirable to have a draft gage connected to the boiler. This draft gage should show the draft under the damper and in the furnaces. The lower this can be kept without undue smoke, the better the results will be. Smoke, of course, shows incomplete combustion,

being made up of particles of unconsumed carbon going up the stack; however, a perfectly clear stack may show even poorer combustion because it shows an excess of air and this excess of air has a tendency to cool off the heating surface of the boiler. For best operation, a slight black haze should at all times show issuing from the stack.

Carbon in the oil combines with the oxygen in the air to form dioxide. If air supplied is insufficient, carbon monoxide will be formed instead. The heat given off due to formation of carbon dioxide is approximately 1400 B.t.u. per pound of oil whereas the heat given off due to the formation of monoxide is only 4000 B.t.u. You can readily see the desirability of having all the carbon in the oil forming carbon dioxide. Flue gas analysis shows the degree of completeness of combustion. Products of combustion should be carbon dioxide, oxygen, sulphur and some water and some sulphur dioxide. In practice, 15.9 per cent CO_2 is all that can be obtained, and the nearer this value is approached, the nearer does the combustion approach completeness. Most oil burning plants average from 12 to 14 per cent CO_2 which is good. The chemistry of combustion is quick and the above is simply the principle itself.

One of the first questions that come up when a plant is considering changing over from coal to oil burning is the comparative cost between coal and oil. Some plants which burn wood may be interested in the comparative cost of coal and oil and wood.

Taking the question of wood first: Average pine wood, dried, which means having been dried in the air from 8 to 10 months runs about 2000 lb. per cord. The heating value per pound of pine wood is approximately 6000 B.t.u. From reference tables it is safe to assume 2¼ lb. of dry wood as being equal to one pound of good grade of coal. Then 2¼ cords of wood are equivalent in heating value to one ton of good coal.

The heating value of coal varies from about 11,000 to 15,000 B.t.u. In this section there is coal obtainable which contains 14,500 B.t.u., but the coal supplied at the present time runs considerably below that value. The heating value of the oil in this section runs from 17,500 to 19,000 B.t.u. Taking oil average as 18,000 B.t.u. per pound and the coal average 14,500 B.t.u., the relative heating value of oil and coal is therefore about 1.27; but oil can be fired much more efficiently than coal, and from tests that have been run throughout the country, it has been found that the evaporation obtained in pounds of water per pound of oil from and at 212 deg. F., varies from 12 to 16 lb., whereas the evaporation obtained from coal varies from 5 to 11 lb., 8 lb. being a good average.

Now, if we consider the evaporation obtainable from oil as 14 and that obtainable from coal as 8, the relative evaporation obtainable from oil and coal equals 1.7. The oil weighs approximately 336 lb. per barrel. Then from the above relation, one ton of coal, 2000 lb. is equivalent to about 1176 lb. of oil, relation being about 3.5. In other words, 3.5 bbl. of oil can be taken as the equivalent to one ton of good coal. Also with the above method of reasoning, two barrels of oil can be taken as equivalent to one cord of pine wood.

From the above relations, it is easy to determine the saving that would be effected by use of oil over coal or wood. This relation of course does not take into account the labor saving, due to the coal and ash handling in the plant and the firemen needed, nor the cleanliness and ease of operation.

All of the foregoing information is general, each plant being a specific case in itself. When a plant is to be changed over to oil burning a big saving may be effected at one plant, whereas in another, there will be a great difference and it is hard to say whether or not there will be an actual saving in oil over coal, unless plant operation is taken into account.

Forest Fires

By J. B. Dillon

MR. JOHNSON, in charge of forest planting work in Rocky Mountain District No. 2, made the statement that a forest fire can destroy within one day what cannot be replaced within 100 yr.

Anent forest fires, 45 yr. ago a fire swept the East and North slopes of Pike's Peak, and all that remained was about 150,000 acres of charred stumps and scorched soil.

It was fully 35 yr. after the fire ere the former verdant hillside showed any sign of tree life—a few little aspens peeping out.

In 1912 the United States forest service set out 3-yr.-old Engleman spruce, Douglas fir and Western Yellow pine. These conifers are of slow growth, 3 yr. in a nursery giving them only 6 in. in height when set out.

The little fellows are placed 8 ft. apart on the slope, 800 to the acre. One man can set out 600 of the little trees in a day. Practically 6000 acres have been stocked.

One of the greatest menaces to the young trees are pack rats—some of them gnawing the trees completely off—but the forest department is using poison to dispose of these pests. Mr. Johnson said it would be at least 100 yr. before these trees are large enough for saw timber.

U. S. Civil Service Commission announces an examination, Sept. 22, for junior drainage engineer to fill vacancies in the Bureau of Public Roads, Department of Agriculture, for duty in the field, at entrance salaries ranging from $1200 to $1920 a year, with necessary expenses while absent from headquarters, and vacancies in positions requiring similar qualifications. Appointees whose services are satisfactory may be allowed the temporary increase granted by Congress of $20 a month. Competitors will be examined in surveying, engineering, and hydraulics; report writing; education, preliminary training, and fitness, and must show that they are graduates in civil engineering from a college or university of recognized standing. Six years of preliminary training in civil engineering showing satisfactory advancement and indicating special fitness will be accepted in lieu of graduation from a college or university. In considering both eligibility and standing, additional credit will be given for undergraduate or postgraduate work in hydraulics or soil technology. Applicants must not have reached their thirtieth birthday on the date of the examination. Apply for Form 1312.

Air Lift Installation and Operation

As THERE are several different air lift systems in use throughout the country, no doubt many of the readers of Power Plant Engineering have such systems with varying equipment in their charge and have their own methods of overcoming the difficulties which at times develop. I, therefore, give the following description of the installations in my charge and which I installed, hoping that it may be of some help to readers who may have an air lift to install, especially on a new well where much sand will be encountered or brought up, and I trust that this may bring forth some discussion of a subject which will prove at once instructive as well as interesting.

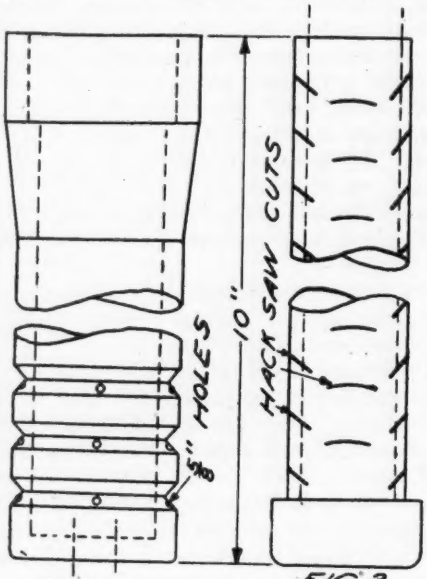


FIG. 1 FIG. 2

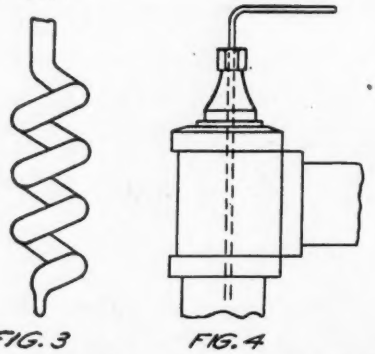


FIG. 3 FIG. 4

FIG. 1. AIR PIPE NOZZLE, SHOWING HOLES IN SERRATED SIDES

FIG. 2. AIR PIPE NOZZLE, SHOWING HACK SAW CUTS THROUGH WHICH AIR ESCAPES UPWARD

FIG. 3. SAND CLEARING DEVICE FOR NOZZLE

FIG. 4. UPPER END OF SAND CLEARING DEVICE, SHOWING STUFFING BOX AND IMPROVISED HANDLE

Our main well, 8 in. by 960 ft., in which the water rises to within 40 ft. of the surface, was originally equipped with a steam-driven, deep well pump; but as the demand for water rapidly increased, this was replaced by an air lift system using a single-stage compressor and two receivers, one at the well and another at the compressor located in the boiler room 360 ft. away. The two receivers are connected by a 2½-in. pipeline running underground and equipped with a bleeder at the lowest end just before entering the receiver at the well to remove any accumulation of water. The receivers are also fitted with drain cocks for the same purpose.

When equipping this well, it was necessary to cut off the casing which extended up to within an inch of the floor timbers of the building under which this well is located, for, to depart from the usual method of suspending a discharge pipe in the well, I intended to use the casing as a discharge. After cutting off the casing with an improvised cutting-off tool, a cap was bored out to a snug fit for the casing and the closed end bored and chased for 4-in. pipe. This was driven down over the well after being coated on the inside with iron cement. Four ⅝-in. holes were drilled through the cap and casing and the two bolted together after putting the bolts through from the inside. Then with a short nipple and a "T" the discharge was continued to a cistern.

The upper end of the "T" was reduced and 200 ft. of 1-in. galvanized pipe was suspended in the well with a brass nozzle, shown in Fig. 1, on the lower end. This nozzle has a ⅜-in. hole through the bottom to allow sand to be readily blown through, and also has four rows of ⅛-in. holes drilled in the serrated side at an angle so that the air passing through will be directed upward. Before this well was put in operation some fellow engineers predicted that I would not get the water to the surface and that a discharge pipe would have to be suspended in the well. We get excellent results, however —150,000 gal. easily in 24 hr. with a receiver pressure of 50 lb., and this has been kept up for the past 10 yr. or longer.

Our small well is 6 in. by 408 ft., not under cover but very near the boiler room, and is connected to the receiver which stands at the compressor. When this well was bored a second compressor was installed and so connected that No. 1 or No. 2 compressor can be used on either well or both wells pumped at the same time by one or both compressors.

The casing on this well was left with a good thread and on this a 6-in. cross was screwed. The upper end

of the cross was reduced and 200 ft. of ¾-in. galvanized pipe suspended on the well with the lower end of this air pipe capped. A 5/16-in. hole was drilled through the cap and the end of the pipe cut with a hack saw, as shown in Fig. 2. These cuts direct the air upward as do the holes in the serrated nozzle (Fig. 1). The discharge to the cistern was continued from one of the side outlets of the cross and from the other a discharge was directed to tanks located nearby at ground level where a reserve supply of water is kept as "make up" for the hot well to which it is piped. This being a new well we had considerable trouble with sand in the air pipe which had to be withdrawn and the sand cleaned out quite often. To overcome this difficulty, I secured some stiff galvanized wire about 5/16-in. dia., shaped up the end to the form of a corkscrew, Fig. 3, and passed it down the air pipe, placing a "T" connection at the top with an old valve bonnet to serve as a stuffing box through which the wire passed as shown in Fig. 4. After cutting off the wire and bending over to form a handle, the wire could be turned in the air pipe. The screw at the other end thus loosens up the packed sand which can then be readily blown through the 5/16-in. hole in the cap. No trouble has been experienced since, for when the well is put to work a few turns of the handle clears the nozzle and discharge begins at once. This well also operates at 50-lb. pressure and supplies an equal amount of water as the 8-in. well with same size discharge opening and same compressor speed.

There is a diversity of opinion as to the best oil to be used in the air end of compressors and the writer would like to hear from different readers relative to the oil they use and experiences along that line.

CHARLES L. RIECKE.

Boiler Tests

THE ACCOMPANYING table gives the result of a series of tests which we made on our boilers some time ago. We run these tests occasionally to find out the things we are interested in knowing about the plant. We think the evaporation is very good; in fact, it is better than we usually get. Our average is around 7½ lb. water per pound coal. Possibly this may be due to the fact that these were sample cars of coal. Our CO_2 was running rather low at that time. We use a sampler taking an 8-hr. sample, and opening the doors to fire does not help any.

We probably ought to have stokers, but so many stoker-fired boilers show so much coal in the ashpit that it causes us to hesitate about recommending stokers. We like our ash heap to look white, and in many stoker-fired plants the ashes look as black as the coal they came from. It seems to us that in those plants where they run the boilers at 200 or 300 per cent of rating, that the items of heat lost up the chimney and coal through the ash dump must be high. How do they figure the great surface in such a case for the normal rating or the overload rating? It looks as though the maintenance of the furnace would be high in such cases.

We started up a new electric motor recently, which vibrated excessively. The pulley was secured with a feather key and set screws. With the pulley removed there was no vibration, which made it a simple problem to locate the trouble. A ¾-lb. counterweight was required on the 12 by 12-in. pulley to make it run free from vibration.

In the early part of last winter, we were informed that a 150-sq. ft., steam heating, cast iron, sectional radiator was leaking badly at the nipples that join the sections. We had no time to take it apart and put in new nipples, so we ventured on putting in a quantity of steel cement mixed with water, letting it stand 2 hr. for the cement to set. It was put into service and has been as good as new ever since.

J. O. BENEFIEL.

TABLE GIVING THE RESULTS OF A SERIES OF BOILER TESTS

Evaporative Test of #4 & 5 Mine Run Coal Under Every Day Operating Conditions. Object - To Determine Which of Two Coals Would Make Steam at the Least Cost. Horizontal Tubular Boilers Hand-fired.	Test #1 Car PRR #296819 Time 10 Hrs. #4 Ind. 7/24/19	Test #2 Time 10 Hrs. #4 Ind. Coal 7/25/19	Test #3 Car PRR #290519 Time 10 Hrs. #5 Ind. 7/31/19	Test #4 Time 10 Hrs. #5 Ind. Coal 8/1/19
No. of boilers of 3000 sq. ft. htg. surface each	4	4	4	4
Total heating surface, sq. ft.	8000	8000	8000	8000
Grate surface 39 sq.ft. each, total, this test	156	156	156	156
Steam pressure gage	135	135	135	135
Cost of coal unloaded	3.70	3.70	3.55	3.55
Total pounds coal weighed to boilers	27696	27618	30779	31487
Total pounds dry coal	25585	25524	28409	29062
Pounds burned per hr. per sq. ft. grate surface	17.75	17.7	19.7	20.2
Per cent moisture in coal	7.58	7.58	7.7	7.7
Pounds ashes	4105	3247	3939	3674
Per cent ashes	14.8	12.18	12.8	11.67
Stack temperature	500-520	500-520	500-520	500-520
Evaporation per sq. ft. htg. surface lb.	2.846	2.86	2.85	2.86
Pounds water metered to boilers	227696	229498	238296	236469
Equivalent from at 212 deg. F.	259650	261541	240280	240904
Pounds water evap.per lb.coal (coal as fired water as fed)	8.22	8.31	7.41	7.51
Pounds water evap. per lb. coal (dry coal,water from and at 212 deg. F.	9.3	9.46	8.44	8.55
Pounds coal per 1000 lb. steam, (coal as burned, water as fed)	121.65	120.33	133.6	133.1
Cost,cents per thousand lb.steam generated	22.5	22.26	23.71	23.62
Per cent CO in flue gas	8.4	8.2	9	
Pounds coal per b.hp.-hr. (coal as burned, water as fed)	3.99	3.94	4.43	4.37
Cost of one b.hp.-hr. in fractions of a cent	.738	.728	.783	.775
Temperature feed water	206	206	206	206
Boiler horsepower rate	694	700	696	721
Efficiency boiler and furnace (coal as fired, water as fed)				
Efficiency boiler and furnace (dry coal water from and at 212 deg.F.)				
Note: No calorimeter determination of coal to find efficiency of boilers				

Why Some Engineers Fail

IN MY WORK, I have occasion to visit power plants of all kinds, and, from the observations which I have made, find that, while in the majority of these plants the men are conscientious workers and may have a good practical knowledge of the equipment in their charge, they lack technical knowledge of this equipment, especially technical knowledge which might be of assistance to them in the solution of problems which are bound to been as good as new ever since.

As a result of this condition, we find that, when changes in plant equipment or layout are contemplated, the operating engineer is, as a rule, not consulted in the matter. Instead, the manager or plant engineer will call in a consulting engineer. This same condition exists when the manager discovers the cost of operation continually rising. Perhaps he will question the operating engineer, and, being unable to secure any definite opinion from him as to the manner in which it might be possible to reduce the cost of operation, he will again turn to the consulting engineer. Consequently, the manager loses confidence in his engineer on questions which may pertain to the economical operation of the plant, or any changes necessary either to bring about more economical

operation or to increase the capacity of existing installation.

I believe that the cause of some of this may be traced directly to the engineer. Instead of spending a little time trying to study the means which might be employed to improve the efficiency of his plant, he will work for hours on an engine pump or other piece of apparatus not only when it is unnecessary to do so, but also when, if necessary, this work might be delegated to some assistant.

In the cities of Tonawanda and North Tonawanda, N. Y., the engineers are not required to take out licenses. The passing of a license ordinance has been urged upon the councils of these cities numerous times, but every time any attempt was made to pass a license ordinance it has failed. As a consequence, many engineers in charge of plants are really not qualified to hold their positions.

It is men of this type who do not want a license law, as they are in doubt of their ability to pass an examination. In my opinion, there is no excuse for any man not being able to pass such an examination and to master the technical knowledge required of an engineer in a power plant. There is no excuse for this, for there are too many good books, correspondence schools and technical papers, by means of which any man who will apply himself can readily obtain the desired or required knowledge.

C. J. MILLER.

Boiler Water

THERE IS nothing that should concern an engineer more than the results obtained by the use of different feed waters, such as usual city drinking water, deep well water and rain water, which is the same thing as surface water or brook water, the last three being practically one and the same thing. We often hear of rain water being soft water and good for use in a boiler; but in my experience, I have seen some of the worst conditions resulting from this so-called soft water. In one plant consisting of horizontal return tubular boilers, the plant had three cemented wells 10 ft. by 12 ft. each, connected together. These wells were used as receivers for all usable return water from the factories, also all rain water from the roofs of the various buildings, and in rainy weather would fill up. The boilers were 18 yr. old and a barrel of scale was knocked off with a knocker and there was about as much left on that did not come off; but, owing to some tubes leaking, it was not thought advisable to continue.

In another large tannery having two 6-ft. boilers which were 20 yr. old the boiler feed water was taken from a nearby brook and on looking into the top manhole, the scale was so thick that one could not see between some of the tubes. In another plant were three 6-ft. boilers. This plant had two 10,000-gal. tanks which received rain water from the roofs of the factory. This plant also had a well 405 ft. deep, so they thought they would use the deep well water because it was the cheapest, notwithstanding it required a 10 by 30-in. vertical steam pump to lift it. They used this deep well water with the rain water about 3 yr. This was 18 yr. ago and the tubes got loaded with scale so they had to discontinue its use, but are still using the rain water, and today it is difficult to keep up steam on two boilers, burning ⅓ screenings and the plant requires less than 300 hp. This scale is ¼ in. thick on most of the tubes. Soda ash and kerosene is freely used and the scale has always come off some by its use, but I believe the rain water is still making scale. I have noticed in all these plants that whenever a boiler is newly started up after having been let down and washed out, the blowoff has to be opened three or four times a day for the first week, otherwise the blowoff will plug up. After two weeks, it is safe to blow once a day.

A large municipal plant equipped with turbines and reciprocating engines is located close by a beautiful looking river very tempting to one looking for so-called cheap water, but this water is used only for condensing purposes and in my estimation they are using rare good judgment in not using it for boiler feed purposes and have better looking boilers today than if they had used it a year ago. But there are engineers who want to make a saving when first taking a new job regardless of its future effects and of course they do sometimes save some water expense at first, but it is the next engineer and the owner who pay for the 13 per cent of coal required to offset 1/16 in. of scale, not to say the need of an extra boiler in some cases.

For the last 15 yr. I have had other plants where boilers were 23 yr. old and others not so old that always used city drinking water and they scarcely showed any scale. This so-called cheap water is often the most expensive.

A. C. WALDRON.

Comments on Back Issues

IN "POINTERS ON REFRIGERATION" of March 15 issue, I find statements upon which I desire to comment.

Statement is made that when the ammonia compressor receives the return gas, so saturated that it freezes up, the oil-trap must be drained or the system will be flooded with oil. The compressor referred to is of the enclosed type with the oil in the crank-case and if the ammonia comes back as a regular stream of liquid, it will mix with the oil and it all passes on to the trap if the compressor head does not give out first and pass it to the atmosphere; but if it gets round to the trap, it will most likely stay right there, since the trap will hold liquid back; in fact, a good and hot discharge is much more liable to cause the system to be coated with oil since the heat will almost vaporize the oil and it will pass through the trap with the ammonia-gas. Some engineers do not believe that much oil can pass over this way, but I have myself cleaned up to 50 buckets full of oil out of a 50-ton brine-cooler and our discharge was very hot.

Another statement conveys the idea that gas and nothing but gas should pass through the expansion valve; this idea I find is held by many, but how can we get only gas through a valve when the pipe on the other side of the valve holds nothing but liquid. If we were trying to do our freezing only with the cold gas, our ice machines would require some large and expensive instruments.

Let us compare the heat absorbing properties of ammonia liquid and gas. To evaporate one pound of liquid ammonia at 15 lb. gage pressure requires 556

B.t.u., which is equivalent to a refrigerating effect of about 0.002 tons. The liquid will have a volume of 0.025 cu. ft. and the resulting gas a volume of 9.03 cu. ft.

If we wanted the same refrigerating effect of ammonia gas at the same pressure and expected the gas to rise in temperature, say 5 deg. F., taking the specific heat of the gas as 0.5, we would need 222 lb. of gas and this would have a volume of 2004 cu. ft. Compare this with the volume of gas resulting from the evaporation of one pound of liquid and we must realize that it would take quite a full-grown compressor to do even a small amount of work, not to mention coolers, condensers and all; besides, the more a gas is superheated the slower will it take up heat; so let us get liquid and nothing but liquid through the expansion valve.

Referring to the old advice about getting close to the floor in case of ammonia trouble because ammonia gas is lighter than air, I will say that ammonia blowing out of a cracked fitting or pipe will by its own pressure be scattered and mixed very nicely with the air, and even if we disregard this side of the question, the textbook tells us that two gases always try to combine and that the greater the difference in density of the gases, the more easily will they mix. So, if I should ever find myself in such a situation, I will get right up on my hind-legs and run for the outdoors or gas-mask for that way I know I can cover ground faster than when I am crawling like a snake.

Reading in the July 1 issue about the man who was burned by hot flue-dust reminded me about a similar case when I just missed getting my feet burned off. I was told that the dust in the back-connection of the furnace was wetted down and cold, so I crawled in to clean it out. As soon as the shovel broke the crust formed by the water, my feet went through and burning hot dust closed in around my feet. I came out from there with scorched shoes, but otherwise safe.

A man who was used to that kind of work was getting ready to clean out the back-connection of a water-tube boiler. He held the nozzle of a hose inside while a helper turned the water on where the hose was connected up. The damper was closed so a cloud of steam shot out and peeled the skin off his arm up to the shoulder.

Once when I was under the back of a boiler picking down the baffle bricks on the lower row of tubes, the head-fireman forgot where I was and started taking the baffle bricks out on the upper row of tubes. The dust on them fell down, taking with it the dust from between the tubes and within a second I was blind and choking. I made a dive for the small door at the back-connection and had I not found it in the first trial, I believe I should not have come out alive. E. MATZAN.

A Study in Traps

AFTER TALKING with a salesman, and then going home and looking through the ads of Power Plant Engineering, it seems to me that some salesmen and some engineers jump at conclusions too quickly.

For instance, a trap salesman, perfectly honest, tells of the vast amount of coal his apparatus will save. "Why," said he, "do you know that a hole only ⅛-in. in diameter will blow steam like the very deuce? Good steam men figure that a trap with 100 lb. of steam back of it will waste over 60 lb. of steam if the opening is only ⅛-in. diameter."

"How long does it take to waste 60 lb. of steam?" I asked him.

"Why, let's see; is it a minute?" said he.

"Let's see; our traps save, under these conditions, about 200 lb. of coal each per day."

"Well," said I, "it must be about 60 lb. per hour then, if you figure 24 hr."

"It takes only 10 traps to save an even ton of the black diamond," said the salesman, "and the cost would be only about $400."

"Now," thinks I, "if coal is about $7.20 per ton, and we run 300 days without labor trouble, the saving would amount to $2160 on only 10 traps, and we have at least 36 or 38. Holy smoke! if we invest $1440, we will save $7776, and surely the boss could afford to give me two or three dollars a week increase. Say, it looks pretty good to me."

So, I rush home and grab up the paper and look for traps, to see if any other trap will save more than 200 lb. of coal per day, but I don't find any guarantees attached to any of them. I begin to wonder if it is possible that there is a "nigger in the woodpile."

Here is the line of deduction I work on.

"Why, I've already got a lot of traps, but they are old-fashioned, and the valves do leak like sieves. I need new traps, that's sure, for, you see, these old 'critters' are absolutely gone, and I want new stuff. I don't want to take the time to repair this pile of junk; I want something modern."

Now, I've got to frame up a speech something like this: "You see, Mr. Kidder (the purchasing agent), we are losing a great deal of money by leaky traps. These traps are obsolete and should be replaced with modern apparatus. We are wasting hundreds, yes, thousands of pounds of———"

"Hold on. Hold on. Just a minute. Are we wasting steam? All of our returns are being used again to augment the feed. They are introduced into an open heater, and no vapor is escaping, as the steam in the returns is condensed by the make-up water."

My goodness! I came near losing two or three dollars per week instead of getting a raise.

Who was it that said, "What fools these mortals be?"

Of course, I'd like modern equipment, but I'll have to think up some other line of argument to get it, and, meanwhile, I wonder if my friend, the salesman, is "getting by." TOM THUMB.

SHE WAS a dainty little thing and was so tickled that her beau was the electrician at the power house. He was all smiles when she came to give the works the once over. While they were making the round, a strapping fellow came in. He was loaded down with blocks, tackle, etc.

"Oh! what does he do?"

"He is a trouble shooter."

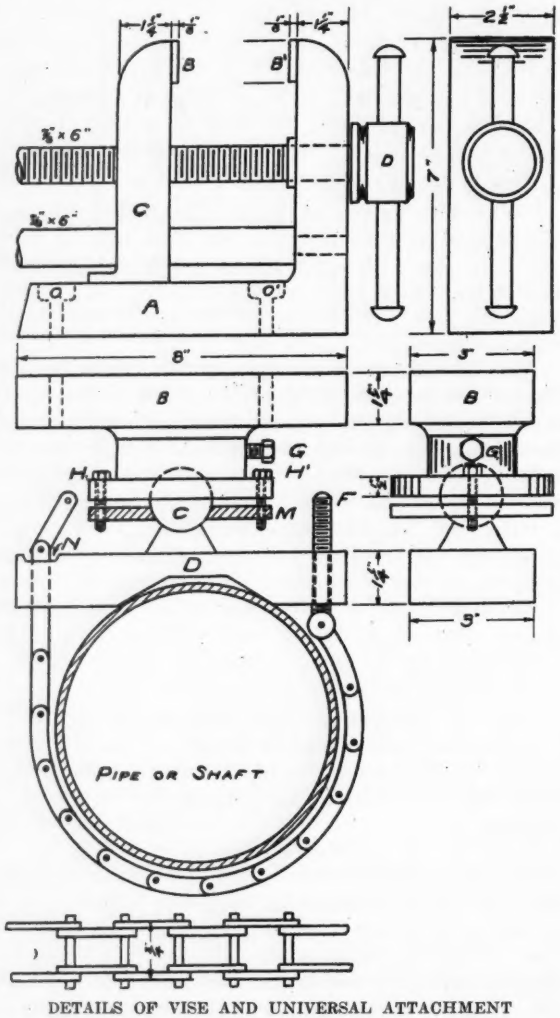
"Hadn't we better go outside? One of us might get hit!"

THE THIEF of time is soon caught in the net of non-production.

A Useful Repair Vise

THE ENGINEER in a power plant, when making repairs or adjustments on engines, or other machinery, is often required to make several trips from the job to the work bench to file small parts or to take them apart.

To overcome that trouble, I designed the vise shown in the illustration. This was made of a 2½ by 1¼-in.



DETAILS OF VISE AND UNIVERSAL ATTACHMENT

steel bar, bent and forged as shown at A. To this body was attached the jaw B¹ made of a piece of a 12-in. file. A ⅞-in. hole was then drilled to receive the screw D. A second hole (¾-in.) was drilled 2 in. below the first one, to take the round guide bar. The movable jaw B and the body C were made of the same material as A. The top hole in which the screw D operates, was tapped ⅞-in. standard. In the body A are drilled two holes o and o¹, 9/16 in. in diameter, and countersunk to a depth equal to the thickness of a ½-in. bolt head.

The illustration shows also the universal attachment through and by which the vise can be secured to a pipe, post, shaft, etc. The part B and DC is best made of a special casting. The vise is attached to the body B by means of two bolts, and held in any position by the set screw or lock bolt, G. The ball C is turned to a diameter of 1½ in. and the bearing surface in the casting B, bored to fit the ball snugly to ½ of its diameter. The retainer ring M is also bored to a good fit on C.

OTTO DORTHEN.

Warp-Proof Doors

WE HAD much trouble with our wood doors warping, until someone hit upon the idea of making a double door, leaving an air space between the two partitions, as shown in Fig. 1. Figure 2 shows the type of frame in which the two partitions are nailed. Either 1½ by 4-in. or 1½ by 6-in. lumber is used for the frame, depending on the size of the door, while for the partition, ⅞ by 3-in. lumber is used.

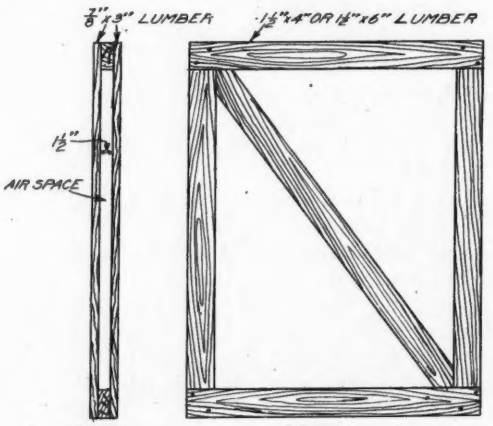


FIG. 1. CROSS-SECTION THROUGH DOUBLE DOOR
FIG. 2. FRAME FOR WARP-PROOF DOOR

This double partition makes the door much heavier than where the single partition is used, but trouble with warped doors, which frequently meant loss of time and production, is eliminated.

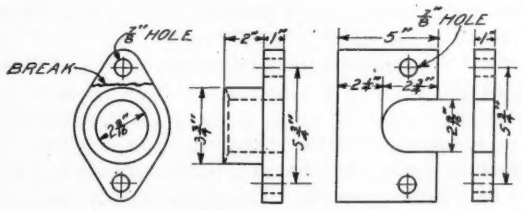
Where the atmosphere is so steamy, as in a boiler room, laundry, etc., that water runs off the inside of

the door, a covering of light galvanized sheet iron helps to keep the water or dampness out of the wood.

We use this construction for both hinged and sliding doors. H. A. JAHNKE.

Retaining a Broken Gland

IN THE accompanying illustration is shown the scheme I recently employed to secure a broken gland on the steam end of an air compressor. A 1 in. thick piece of iron 5 in. wide and of a length the same as the



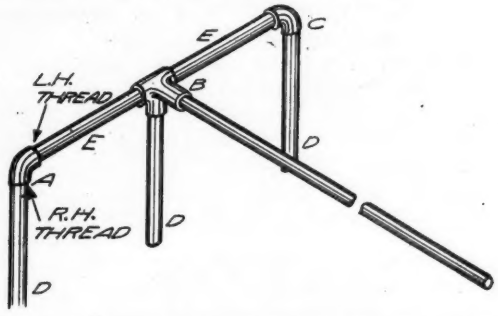
DETAILS OF BROKEN GLAND AND RETAINING PIECE

gland and drilled and cut as indicated was placed back of the gland. It was, of course, necessary to use somewhat longer stud bolts because of the added thickness.

W. F. JOHNSON.

Fire Rake

A LIGHT RAKE that can be used in raking, leveling or pulling clinkers can readily be made of pipe and fittings. I first made one of ½-in. pipe, but found it was not heavy enough. Then I tried ¾-in. pipe and found that gave the right balance and was heavy enough, but not so heavy as a solid rake.

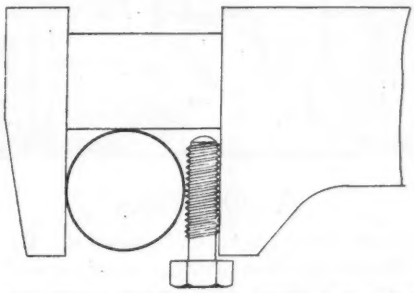


USE OF PIPE AND FITTINGS IN MAKING FIRE RAKE

At A, in the illustration, use a right and left ell. If you don't, that end will loosen as you push back. At B, use a side outlet tee, and at C, a regular ell. The teeth, D, are made 5 in. long, while the handle can be made any length desired to suit the depth of grate. The nipples, E, should be about 2½ in. long. W. N. L.

Improvised Pipe Wrench

FREQUENTLY, when it is necessary to pull up small size pipe, it is found that no regular pipe wrench is available. The writer was recently caught in such a situation and solved it in the manner illustrated. A standard monkey wrench was used, employing as the gripping jaw a sharp threaded bolt placed in the wrench jaw. In the case in point, we found that the single bolt jaw gave sufficient grip, although if it is found that the use of but one bolt permits the pipe to slip, another can be used on the upper jaw of the wrench. While this method, of course, takes more time than the use of a

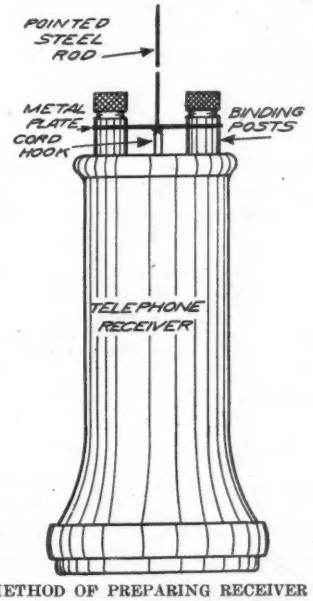


METHOD OF USING MONKEY WRENCH AND BOLT AS AN EMERGENCY PIPE WRENCH

regular pipe wrench, it is nevertheless worth bearing in mind for use at those times when the pipe wrench is not handy. M. A. SALLER.

Sound Locator Made from Telephone Receiver

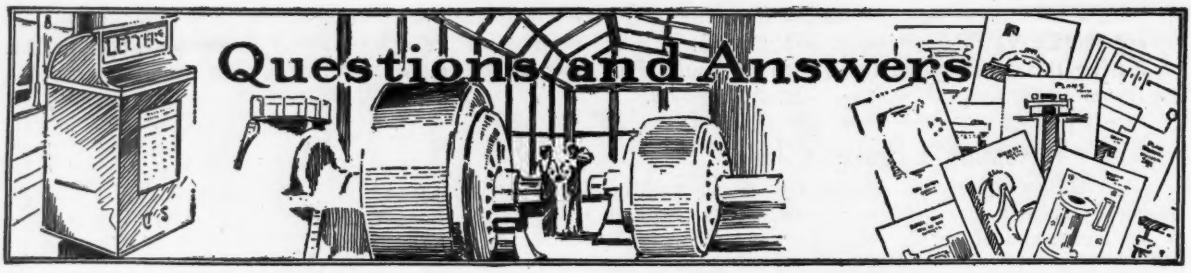
A GOOD sound locator can be made from an old phone receiver by taking a steel rod of the desired length and making a head on one end. Take a light steel disk of, say 1/32-in. thickness and punch holes for the receiver binding posts and steel rod. Put the head



SHOWING METHOD OF PREPARING RECEIVER TO LOCATE KNOCKS

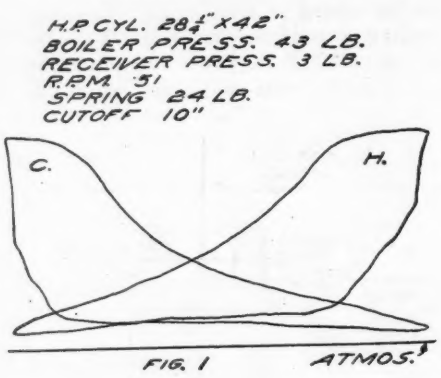
of steel rod through disk and clamp on receiver posts as shown. Let the head rest on receiver cord hook. This will intensify sounds in engine cylinders to an astonishing degree, as well as in meters, steam pipes, bearings, etc. HAYMAKER.

THE EDITOR of a religious denominational paper makes objection to the metric system on the ground that he would not want the Bible to read, "neither do men light a candle and put it under a hectoliter, etc."



An Old Timer

HEREWITH ARE cards taken from a John Roach, compound, horizontal, back acting (grasshopper) engine, installed on a 1300-ton ship, which I submit to your readers for criticism. The cylinders are 28¼ in. and 42½ in. by 42 in. stroke. The maximum pressure is 65 lb. using four boilers. The cards were taken at 43 lb. which is all that is obtainable using two boilers. Meyer, variable, riding cutoff valves are used. The maximum vacuum is 17 in. The cutoff in the high-pressure cylinder is at 10 in. with steam at from 40 to 45 lb. The coal consumption, including all auxiliaries



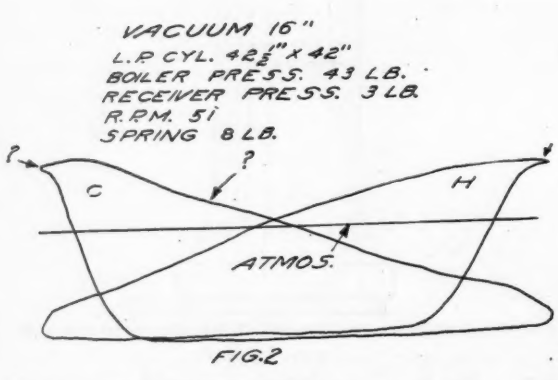


FIG. 1. HIGH PRESSURE INDICATOR CARD FROM A JOHN ROACH HORIZONTAL COMPOUND ENGINE
FIG. 2. LOW PRESSURE CARD

and an average of 3.5 kw. electric load 24 hr. a day is 8.8 tons using two boilers and 12.5 tons for three boilers.

I realize that this steam pressure is ridiculously low on which to operate a compound engine, but such operation gives economical results—a ton-mileage (nautical mile) of approximately 19, using two boilers.

This engine is certainly a curiosity, having been built in 1874 and in use steadily ever since.

I would appreciate comment on these cards and have indicated by arrows a few points on which I especially desire information, such as the sharp points in admission lines of low-pressure cards, the drop in steam lines of low-pressure cards, and the irregular compression lines of the high-pressure cards. The steam is very wet. Is this responsible for the wavy compression lines?

E. L. K.

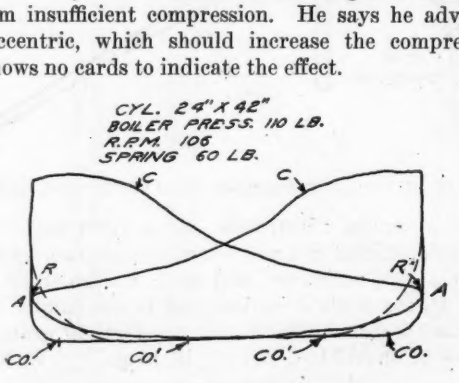
Suggestions for Eliminating the Pound

REGARDING the indicator card from A. B. C.'s Wetherill engine in the Aug. 1 issue, I believe the pound can be eliminated by advancing the exhaust eccentric still further.

For an engine of this size and speed, the compression appears too light. Exhaust valves show late opening and this will also be remedied by advancing the exhaust eccentric. The pound was no doubt caused by the slipping of the exhaust eccentric, and should disappear when the compression is increased to the proper point.

F. G. SCHOENFELD.

A. B. C., ON PAGE 765 of the Aug. 1 issue, complains of his Wetherill engine pounding and asks for suggestions. If the engine is keyed up well and is neither brass nor key bound on the connecting rod brasses, it is from insufficient compression. He says he advanced the eccentric, which should increase the compression, but shows no cards to indicate the effect.



CARDS FROM AN ENGINE WHICH POUNDS

The card shows that the engine is fairly well loaded, that the latch plates and block are worn and that the dashpot is slow in closing (round corner at c). This last would cause the expansion line C-R to run high and maintain a high terminal pressure at R. This point also indicates that the release does not occur until the extreme end of the stroke. The exhaust line is choked as shown by the curved line down from R. Compression

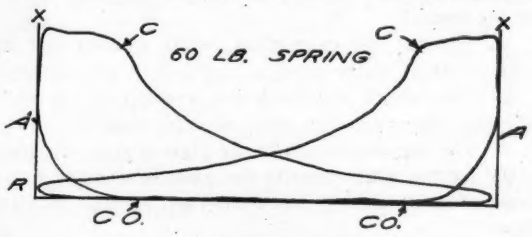
should begin, i.e., the exhaust valve should close at about Co' instead of where it does at Co. (Note the compression curve in the diagram for Wanted—Criticism.)

Improvement can be made by tightening the valve mechanism connections and by further advancing the eccentric. This will cause the exhaust valve to open and close earlier in the stroke, which will produce a card that will follow approximately the dotted lines. Looseness in the quarter boxes, crosshead shoes, and connecting rod boxes will also produce a pound and should be investigated. There are further causes which are applicable only to individual cases. R. A. CULTRA.

Wanted—Criticism

ON PAGE 765 of the Aug. 1 issue appears a set of indicator cards on which Mr. Jones asks criticism. The cards are, on the whole, fairly good for general engine operation, and about what could be expected from a machine several years old.

The admission line, beginning at A and going up, leans in slightly. It should more nearly approach the vertical line X-A. This may be caused by looseness in the valve mechanism, which could be eliminated by tightening or bushing the pins and connections. The



WHAT I THINK OF THIS CARD

valve setting should not be altered, as the point of admission is about correct. The steam line drops slightly from X to C indicating wiredrawing, through either the throttle valve, steam valve, or ports. The cutoff at C is rather rounded, showing that the latch plate may be worn or that the dashpot may not be closing sharply.

The expansion line from C to R is good, but shows a slight leakage of steam after cutoff occurs. This gives a terminal pressure at R that is somewhat higher than necessary. The exhaust appears to be choked as if the opening was not sharp enough. This condition may also be caused by looseness in the valve mechanism, anywhere from the valves to the eccentric strap. The aggregate play from all connections may amount to a considerable quantity at the valve. The back pressure line indicates about 18 lb. pressure which is good practice. The compression curve from Co to A is proportioned correctly. The general outline is good, but I should advise tightening all connections.

R. A. CULTRA.

Proper Back Pressure of Compressor

ON A VILTER ice machine used for cooling, the suction pipe and part of the cylinder heads are continually frosted over and the discharge pipe is always cold, only occasionally warming up a little for a few minutes and then turning cold again without opening the expansion valves. I am carrying from 15 to 18 lb. back pressure and from 120 to 125 lb. head pressure and the temperature in the cooling rooms is from 32 to 38 deg. F. By carrying about 10 lb. back pressure, the discharge pipe will remain hot but the temperature in the rooms will rise. After trying out all different back pressures, I find I get the best results from 18 to 20 lb., but not as good as I think it ought to be. With other machines with which I have had experience, I found that I received the best results by manipulating the expansion valves so that the discharge pipes were hot. This machine has fairly good compression and runs 50 r.p.m. Should the discharge pipe be hot on a slow-speed machine? The machine has a water jacket, but by putting water in it, it starts to freeze. E. A. R.

A. On a Vilter machine, the discharge line should be hot. The best results are obtained when the gas leaving the compressor has a temperature of between 180 and 200 deg. F.

When the discharge is cold, it is evident that the compressor is handling excess liquid. This liquid will fill all the clearance space and will expand during the return stroke of the piston. The pressure that results will hold the suction valve closed until the piston has traveled part of the stroke and in this way will prevent the compressor filling to its full volume with vapor from the evaporating coils.

One of the most common causes of cold discharge lines is short direct expansion coils. For coolers where a temperature of from 32 to 38 deg. F. is to be maintained, the coils should not be shorter than 1000 ft. Liquid fed into a coil of this length will be evaporated and pass into the suction line in a slightly saturated state.

If the piping of the rooms is arranged so that each room has two or more coils and expansion valves, it will be found that better results can be obtained by the use of one coil and one valve.

A coil made up of 2-in. pipe can easily be 2000 ft. long and still allow ammonia in a saturated state to pass through its entire length.

Arrange direct expansion piping so as to have long coils and as few expansion valves as possible. Feed the ammonia in at the bottom of the coil and take the suction from the top.

The coils must be clean both inside and outside. Ice and frost should not be allowed to accumulate, as its presence will prevent the heat of the room from passing to the ammonia in the coil. Oil on the inner surface of the coil is also an insulation against proper heat exchange.

A back pressure of between 20 and 25 lb. should give good results.

The water in the jacket will not freeze if it is circulated freely and the compressor kept at a proper temperature. A. G. SOLOMON.

Apportioning Fuel Costs

WILL YOU kindly inform me as to the actual pounds of coal required, or chargeable, to the production of 48,000 lb. of steam extracted from the first stage of a turbine during a 24-hr. day (for heating and other pur-

poses) with a coal consumption of 42,000 lb? Evaporation is 363,500 lb. of water. W. T. H.

A. You do not give us sufficient data to enable us to figure out accurately the proportion of coal which should be charged to heating purposes. We can, however, give you the method for doing this and, as an example, have selected the following conditions:

Initial steam pressure 150 lb. gage, steam pressure after first stage 70 lb. gage, vacuum 26 in., temperature of heating returns to boiler 200 deg. F.

We find, by referring to steam tables, that at 150 lb. gage one pound of steam contains 1195 B.t.u. and at 70 lb. 1183.3 B.t.u. Condensate at 26 in. vacuum contains 93.28 B.t.u. per pound and the heating returns at 200 deg. contains 167.94 B.t.u. per pound.

Total heat of steam $363,500 \times 1195 = 434,382,500$ B.t.u. (product 1).

Total heat used in first stage $363,500 \times 11.7 = 4,252,950$ B.t.u. (product 2).

Total heat of steam to second stage of turbine $(363,500 - 48,000) \times 1183.3 = 373,331,150$ B.t.u. (product 3).

Total heat of steam to heating system $48,000 \times 1183.3 = 56,798,400$ (product 4).

Total heat in turbine condensate $(363,500 - 48,000) \times 93.28 = 29,429,840$ (product 5).

Total heat in heating returns $48,000 \times 167.94 = 8,061,120$ (product 6).

The total heat used in the turbine is then found by adding product 2 and product 3 and subtracting product 5. This gives 348,154,260 B.t.u. used in the turbine.

The total heat used for heating is found by subtracting product 6 from product 4, which gives 48,737,280; the coal used is then to be proportioned between these two figures.

The per cent charged to heating is found by dividing 48,737,280 by 396,891,540 and gives 12.3 per cent. Multiplying 42,000 lb. of coal by this figure gives 5166 lb. as the proportion to be charged to heating.

In figuring this example, it has been assumed that all steam has been returned to the boiler. If this is not the case, the figures which represent the heat value of the heating returns and the turbine condensate will be altered. We believe that this method which proportions the coal according to the actual heat content of the steam used in the various parts of the plant is the most accurate one and, therefore, to be recommended. By substituting the actual figures in your case, and referring to steam tables for the heat content of your steam and water, we believe that you would be able to work out the proper proportion of the coal which in your plant should be charged to heating purposes.

Draining Separators to One Trap

WOULD IT be feasible to run the drains from several steam separators into one trap? I have a 20-hp. blower engine, a 10-hp. high-speed engine, and a steam driven compressor of 1000 cu. ft. free air per min. capacity. Am running the drains from these separators into one trap and I have been told that it would not work because the steam from the drains would be traveling at different velocities. W. F. B.

A. It is not customary to drain all the separators to one trap, although such a thing may be done with entire satisfaction, depending upon the pipe system, and the difference in steam pressure between the different separators. If you have such a condition that one separator is under considerably less pressure than another, there is a possibility of driving the condensate from the high-pressure separator into the receiver of the low-pressure separator. Thus instead of giving dry steam from the low-pressure separator, you are likely to pull over considerable water into the engine or steam driven unit.

Another difficulty which may occur when the separators all drain to one trap is when one line containing a separator is cut off from the main header while other separators are in active use. In that case, it is likely that steam will be passed from the separator in use into the line which is supposed to be dead, unless some provision is made for shutting off the connection. The difference in the speed of the steam will not have any appreciable influence on the operation of the trap.

Massachusetts Examination Questions for First-Class Fireman's License

WHAT would you do when you went into a plant to get up steam?

A. Try out the gage glass, water column and gage cocks to see if water level is right; then get fire going.

2. What would you think was wrong if the glass was full, and the third try cock showed steam?

A. The top connection to the glass is shut or plugged or the bottom connection to the glass is stopped and the steam after some time has condensed enough to fill the glass.

3. How can you tell whether the connections to gage glass are clear?

A. Shut the bottom valve and open drip; steam should blow through. Shut the top and with bottom open, water should blow through; if it does, the connections are clear.

4. If the side walls of your firebox began to fall down, what would you do?

A. If this was the firebrick, I would change boilers as soon as convenient and re-lay the wall.

5. What is a check valve for?

A. This valve, when placed on the feed line, allows the water to enter the boiler, but will not let any water out.

6. What is the shape of a manhole or handhole, and why are they made in that shape?

A. They are nearly oval in shape. They are made this shape so that they may be put on from the inside and allow the pressure to assist in holding them in place.

7. If the check valve leaks, will the water leave the boiler?

A. If the discharge valves on a pump were in order, they would act as a second check valve and the water could not escape from the boiler.

8. How many ways are there to feed a boiler?

A. Pump, injector, city feed, trap feed or gravity return.

9. How do you feed a boiler with no steam pressure?

A. Usually in that case, we use city pressure; some places the pump is worked by hand.

10. What would you do if the blowoff pipe broke inside or outside the setting?

A. If it broke inside, it would put the fire out, or blow it out in the boiler room. If it broke outside, I would start feed as fast as possible and deaden the fire.

11. What would you do if you opened the blowoff and could not close it?

A. I would open it again, and try to blow out the matter in it; if this would not remedy the trouble, I would deaden the fire and speed up my pumps.

12. How do you get a boiler ready for inspection?

A. Empty it of water and wash it out. Clean combustion chamber, remove manhole and handhole plates, steam gage off and brush down walls.

13. How can you tell whether the blowoff valve is leaking?

A. If leaking, the pipe will be hot. Some places they have a drip with a valve on near blowoff valve, which is left open when blowoff valve is shut.

14. How would you cut in a boiler?

A. Get the pressure up to within 5 lb. of the boiler that is running, then start to open main stop valve; by the time the valve starts to open, the pressures should be equal.

15. If you bank your fire at night, and the next morning you find the fire burned out and no water in the boiler, what would be the trouble?

A. The fire in burning out has generated steam which has gone out the pipes.

16. Is the temperature of steam and water the same at the same pressure?

A. They would be the same if in the same vessel.

17. What part of a return tubular boiler will be first affected by low water?

A. The upper rows of tubes and the rear head above the tubes to the fusible plug.

18. Why is the blowoff pipe connected to the rear of a return tubular boiler?

A. The rear end of the boiler is lower than the front end and by placing the blowoff at the bottom of the shell near the rear end, all the sediment can be drained out.

19. What precaution would you take in blowing off a boiler?

A. Open the valve or cock very slowly so as not to put any more strain than possible on the pipe. Close the same way.

20. How would you handle a foaming boiler?

A. With foaming there are some impurities in the water and the thing to do is to check the fire as much as possible and renew the water.

21. What would you do if the water in the gage glass dropped very suddenly while you had a heavy fire?

A. I would test my gage glass to see whether that was all right; if it was, I would put on extra feed, then look around to see whether the blowoff was leaking or where the steam was going.

22. Why should you clean your fires as quickly as possible?

A. So as to prevent any more air than necessary from entering over the fire, for it is not good for the boiler or setting to have cold air come in contact with them.

23. What is the best time to blow off the boiler?

A. When the boiler is not working. The sediment has been deposited on the bottom and by opening the blowoff, most of the sediment will be blown out.

24. What boilers have staybolts?

A. Locomotive type have them in the water leg supporting the firebox sheet. Vertical fire tube boilers have them in water leg for the same reason.

25. How are boiler plates secured together?

A. By riveted joints. Most of the girth seams are single riveted, while the longitudinal joints are usually of double-strap butt-joint construction.

26. Describe the working of a damper regulator.

A. Steam acts (after being condensed) upon a diaphragm, which acts upon a lever, which operates a double ported valve. As the pressure rises the lever moves up, opens valve and allows water to blow under a piston and forces it up. This allows damper, which is connected by a chain, to close.

27. In starting a cold boiler, steam pressure is only 25 lb., but the gage registers 200 lb. What is wrong?

A. If this gage had been frozen, and is now thawing out, the tube would expand and show a false pressure.

28. What would you do if the steam gage showed 200 lb. and the safety valve which should blow off at 150 lb. had not opened?

A. Cover the fire so as to check the generation of steam. Then when the gage showed 150 lb., I would go up and open the valve by hand. If you should open it when the gage showed 200 lb., there would be danger of causing boiler to explode.

29. Where is the steam gage placed?

A. It should be connected to the highest steam space of the boiler.

30. What is the loop or siphon for?

A. This siphon is placed in the pipe line between the boiler and the steam gage and acts as a condenser which prevents the steam from coming in contact with the gage, which would damage it if it did.

31. How many kinds of fusible plugs are there?

There are three plugs that can be used, the long outside, long inside and the short inside or tube plug.

32. What is a fusible plug?

A. A composition shell filled with 99 per cent pure tin which will melt if the water drops below it and give warning to the fireman that his water is very low. It should be understood that water will conduct the heat away; but as the water drops, the steam, which is a non-conductor of heat, will allow the fire to melt the plug.

33. How can you tell if the plug melts?

A. You will hear the steam escaping.

34. Where is the plug located in the B. & W. horizontal return tubular, vertical, Manning and locomotive boilers?

A. B. & W.—Plug is placed in the first course of the steam drum not less than 6 in. from bottom; horizontal return tubular—in rear head not less than 2 in. above the top row of tubes; vertical tubular—in an outside tube not less than ⅓ the length of the tube from the lower tube sheet; Manning—same as vertical; locomotive—the plug is placed in the crown sheet.

35. Why are plugs made so they will project inside the boiler one inch?

A. To prevent the end from getting so hot, as water

will have a better chance to conduct the heat away; also, to prevent the end from becoming covered with scale.

36. Why not make the plugs 6 in. long?

A. There is no necessity for having a plug so long; it would take longer for it to melt and a 1-in. projection is sufficient.

37. How can you tell whether the check valve on a low-pressure heating system is leaking?

A. Fill the boiler with water, and with the stop valve closed, bring pressure up to 10 lb.; if the pressure drops after shutting off the water and the return pipe is colder, the check valve leaks.

38. How would you shut down a low-pressure gravity return system?

A. Shut off return valve; then steam.

39. If you have a pipe break on the above system and you shut off the steam first, but water comes out of the broken pipe, what is the trouble?

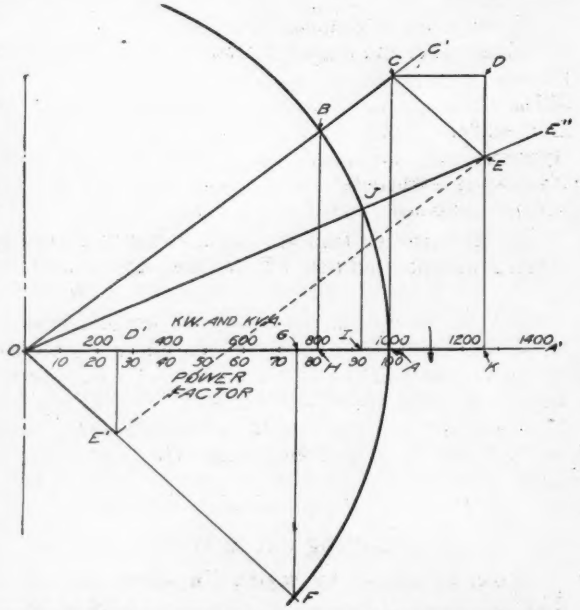
A. The check valve is leaking, water is backing up return pipe. This is the reason why we shut the return valve first.

40. If your return pipe broke in the basement, what would happen?

A. Water standing in the pipe would run out, and if the check valve leaked, most of the water in the boiler would escape. W. N. L.

Power Factor Correction Problem

WHAT IS the power factor of a synchronous motor necessary to drive a pump and raise the power factor of a 1000-kw. system from 80 to 90 per cent, assuming the pump to require an input of 250 kw. to the motor?



VECTOR DIAGRAM SHOWING THE RESULT OF CONNECTING A LOAD OF 250 KW. AT 74 PER CENT POWER FACTOR (LEAD) ON A SYSTEM OF 1000 KW. AT 80 PER CENT POWER FACTOR (LAG)

What is the kilovolt ampere capacity? F. L.

A. Problems involving weighted power factors can best be solved graphically by vector diagrams and then if extreme accuracy be desired the diagrams may be solved mathematically. For the problem in question, first describe a semicircle around the point O with a radius that may be readily divided into even fractions of 100. For instance, make line OA 5 in. in length. Each inch on line OA represents 20 per cent power factor or 200 kw. Draw a vertical at 80 per cent until it intercepts the circle and draw line OC′ which represents the direction of the kv.a. of the 1000-kw. system although the length is unknown as yet.

Now assume that each inch on any radial line represents 200 kv.a. and lay off OA equal 1000 kw. (5 in. from O). Project the vertical AC until it intercepts the line OC′ and the distance OC represents the kv.a. of the 1000-kw. system before any corrective measures are taken. By measurement, it will be found that this line is 6.25 in., which represents 1250 kv.a. As a proof, 1250 kv.a. at 80 per cent p. f. = 1000 kw.

Next we want the final power factor to be 92 per cent. Raise a vertical at the 92 point on line OA′ until it intercepts the circle, and draw line OE″. This line represents the final kv.a. of the system.

The synchronous motor consumes 250 kw. so lay off OD′ equal to 1.25 in.; but this must be added to OC, so lay off CD 1.25 in. parallel to line OA. Dropping a vertical from D to E and joining C and E will give the direction of the kv.a. necessary to make the resultant have the direction OE″ or 92 per cent power factor. Lay off OE′ equal and parallel to CE to complete the parallelogram OCEE′. It measures 1.65 in., which shows that the kv.a. of the motor must be 330 kv.a. Prolong line OE′ until it intercepts the circle at F and drop the vertical FG. This shows that the power factor of the motor alone must be 74 per cent leading.

The length of the line OE is 6.75 in., showing that the total kv.a. now on the system is 1350. The projection of OE on line OA′ or the length OK is 6.25 in., showing that the total kw. of the system is now 1250. Therefore the following figures are apparent:

Kw. of system before correction, line OA.....1000 kw.
Kv.a. of system before correction, line OC....1250 kv.a.
Power factor before correction, line OH..80 per cent lag
Kw. of synchronous motor, line OD′.....250 kw.
Kv.a. of synchronous motor, line OE′.....338 kv.a.
Power factor of synchronous motor, line OG...
.....74 per cent lead
Kw. of system after correction, line OK.....1250 kw.
Kv.a. of system after correction, line OE....1350 kv.a.
Power factor after correction, line OI..92 per cent lag

Apparently a synchronous motor of about 350 kv.a. capacity would give the desired results.

VICTOR H. TODD.

Eliminating Excessive Back Pressure

PLEASE tell me what is wrong with our three-ton refrigerating machine, direct cooling. We had it overhauled and put in first-class running order. It makes plenty of frost on cooling coils with 5 lb. suction pressure and 150 lb. back pressure. The machine is shut down in the evening; but when I go to start it up in the morning I find the suction pressure to be 15 lb. and back pressure 300 lb. What should we do to remedy this condition? D. A. F.

A. The rise in the back pressure from 5 to 15 lb. during an all-night shut-down is easily explained.

While the machine was being operated the evaporated heat-laden ammonia was taken from the direct expansion coils and sent to the condenser. Stopping the machine also stopped the circulation of the ammonia.

At 5 lb. pressure, the ammonia in the coils had a temperature of about 17 deg. F. below zero. Now, if the room temperature was zero, the temperature of the ammonia in the coils would take the same temperature in a short time after the machine was stopped.

At zero temperature, the pressure of saturated ammonia vapor is 15 lb. gage. With higher temperature, the pressure will also rise and the vapor will turn into a superheated gas. Just how high the pressure will go will depend on the temperature of the room and the amount of ammonia left in the coils when the machine is stopped.

A back pressure of 30 or 40 lb. is not uncommon at the end of a 12-hr. shut-down.

On starting the machine in the morning, the liquid valve should not be opened till the back pressure has been pumped down to the point at which it is carried while operating normally.

The condenser pressure of 300 lb. is a dangerous proposition. The cause of this excessive rise is a clear case of imprisoned ammonia and a warm room. While the machine is running the cold circulating water removes the heat from the ammonia.

At night, when the machine is shut down and the water shut off from the condenser, the heat of the room where the condenser is located, causes expansion of the imprisoned ammonia.

The only remedy is to place the condenser in a cool room or put it outside of the building where air can circulate around it. Of course, the pressure could be kept down by circulating a small amount of water through the condenser during the night, but that would be costly. Place the condenser on the roof if the building is not over two stories high and put a roof over it to protect it from the heat of the sun.

A. G. SOLOMON.

Peculiar Collector Ring Defects

I HAVE an alternator (in operation but 8 mo.) on the collector rings of which two small black spots persist in appearing, this in spite of any amount of polishing I may do.

The machine is a 240-v., 2-phase, 4-wire generator operating at 164 r.p.m.

If you could tell me the cause of this trouble and suggest a possible remedy, I should greatly appreciate the favor. F. A. B.

A. Some years ago, the writer, while in charge of a lighting station, had a similar experience with collector rings on a revolving field alternator. Two small spots developed on these rings, which it seemed impossible to eliminate even after turning down the rings and sandpapering them.

For a short time after this work had been done, no evidence of the spots remained. Operation was normal and no sparking occurred. After about 24-hr. run, however, slight sparking set in, and after another 4 or 5 hr. run, the spots would re-appear. In this particular case, we discovered that the spots in the rings were directly opposite the points at which the field winding terminals were sweated onto the rings. Evidently in doing this, the otherwise hard copper ring became softened at these points, and as a consequence, wore more rapidly than the remainder of the rings.

It is undoubtedly this same trouble which you are experiencing, and as long as you employ these rings we doubt whether you will be able to remedy matters. Of course, you will be able to effect a temporary remedy by turning down the ring and sandpapering it so as to obtain a perfectly smooth surface. This will, however, remain so only for a comparatively short length of time, when the spots will re-appear and, with the accompanying sparking which will set in, will only become worse and worse.

In view of the fact that this machine has been in service but 8 mo., we assume it is a new generator. If such is the case, we feel sure that upon taking this matter up with the manufacturers they will certainly be willing to rectify this matter for you, either by sending you a new rotor or at least providing you with new collector rings.

Reducing Scale-Forming Properties of Water

I DO NOT KNOW what is best to do to overcome the formation of much boiler scale. In the feed water, we use a small amount of soda ash and the water naturally contains a little very dilute sulphuric acid. The following is the result of test made on the water:

	Per Cent
Moisture	46.8
Total Solids	53.2
The total solids contain:	
Combined water and organic matter	18.9
Oil	2.1
Silica	2.5
Iron oxide	1.5
Gypsum	59.2
Magnesium carbonate	5.7
Sodium sulphate	4.0

Any information that you can give me in regard to overcoming this condition will be much appreciated.

C. N. M.

A. Under conditions mentioned, we would advise C. N. M. to increase the amount of soda ash he is feeding. Not having an analysis of the water, we cannot suggest about how much he should increase his feeding; but if he will increase it a little at a time until the gypsum is all converted, he will find much better conditions in his boilers. F. F. V.

Cutting Off at 6 In.

WHAT IS MEANT by saying "a valve cuts off at 6 in."? H. R. D.

A. What is probably meant by "cutting off at 6 in." is that the valves are so set that steam is cut off after the piston has traveled 6 in. forward.

THE SUCCESSFUL chief engineer not only must be able to control his subordinates, but also the financiers, it would seem.

POWER PLANT ENGINEERING

Trade-Mark, Reg. U. S. Pat. Office

Issued the 1st and 15th of each month. Established over 24 yr.

Published by the TECHNICAL PUBLISHING CO.
537 South Dearborn Street, Chicago.
New York Office, 150 Nassau St.

Subscription price $1.50 a year in postal zones 1, 2, 3, 4 and 5, which include all postoffices within a distance of 1400 miles from Chicago.

Subscription price $2.00 a year in postal zones 6, 7 and 8, which include all postoffices more than 1400 miles from Chicago.

Copies, current issue, 10 cents; back numbers, 20 cents.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Copyright, 1920, by Technical Publishing Co.

Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the act of March 3, 1879.

Member, Associated Business Papers.
Member, Audit Bureau of Circulations.

Circulation of this issue 22,600

CONTENTS

Where Electricity Is a By-Product. Illustrated....871
Lubrication and Lubricants. By G. B. Upton. Illustrated...875
Chimney Cleanout Door for Draft Regulation. By Claude C. Brown. Illustrated....878
John Anderson. By George H. Wallace. Illustrated....879
Water Gas Meter Explodes. Illustrated....880
Concrete Fuel Oil Storage Tanks. By J. E. Freeman. Illustrated....881
The Cranky Pump. By John S. Carpenter....883
The Lighting of Power Houses. By A. D. Bell. Illustrated..885
Exciters and Systems of Excitation. By H. R. Summerhayes.888
Supporting a Multiple-Conduit Run. By George H. Drone. Illustrated....890
Hoisting Problem. By Fred C. DeWeese. Illustrated....891
Hazards in Gas Welding and Cutting. Illustrated....892
Hydroelectric Power in Ontario. By W. L. Edmonds....896
An Emergency Well Met. By A. W. Kramer. Illustrated....897
Something New in Non-Skid Ladders. Illustrated....899
Oil Burning. By F. G. Hummel. Illustrated....900
Forest Fires. By J. B. Dillon....903
Letters Direct from the Plant: Air Lift Installation and Operation. Boiler Tests. Why Some Engineers Fail. Boiler Water. Comments on Back Issues. A Study in Traps. Illustrated....904
Successful Kinks from the Power Plant: A Useful Repair Vise. Warp-Proof Doors. Retaining a Broken Gland. Fire Rake. Improvised Pipe Wrench. Sound Locator Made from Telephone Receiver. Illustrated....908
Questions and Answers: An Old Timer. Suggestions for Eliminating the Pound. Wanted—Criticism. Proper Back Pressure of Compressor. Apportioning Fuel Costs. Draining Separators to One Trap. Massachusetts Examination Questions for First Class Fireman's License. Power Factor Correction Problem. Eliminating Excessive Back Pressure. Peculiar Collector Ring Defects. Reducing Scale-Forming Properties of Water. Illustrated....910
Editorial: Wages for Work. Present Gains vs. Future Losses. New Subscription Price....916
Development of Pit River Planned....918
Cut in Power Consumption Ordered....918
No-Accident Week....919
News Notes....919
Trade News....920

Wages for Work

There is indication of a return to sanity in the method of determining wages in the recent decision of the Industrial Court of England on an application for a general raise. Basing wages on the cost of living, regardless of value of the work done or the demand for the product can result only in a condition of uncertainty and industrial disaster.

It has been so often pointed out that an increase in wages paid for a given output increases cost of products, hence cost of living, that it is an old story. Yet the see-saw is being continued in wage adjustments—raise wages, raise prices; raise wages, raise prices.

A man is entitled to pay in proportion to the wealth that he produces; but the value of his product, the price for which it can be sold, depends on supply and demand. If the cost to manufacture, due to high wages and high cost of materials—which in turn is largely due to high labor cost in producing those materials—becomes greater than the price which can be obtained, sales will stop, manufacture will stop, and the worker's occupation will be gone. No employer can continue for long to make and sell at a loss, nor at present high costs to make and pile up stock for future sales, hoping to get higher prices later.

So long as frequent increase in wages is imminent, industry is unstable and employers cannot take contracts for products which require considerable time to manufacture, for there is no way of telling what the cost will be.

In the English decision, it was found that, spite of some increase in cost of living, there had been in the industries concerned a falling off in demand and prices. Further increase in wages and priees would result in less demand, and injure the industries, employes as well as employers; hence, no increase in wages was granted.

Spite of the talk of radical agitators, the only way that cost of living can be lowered is by increasing the output per dollar of wage cost. In most trades, the men are saying that they would prefer the prewar scale of wages and prewar prices for goods to present conditions. Financiers and economists say that it can never be, but that some reduction is to be hoped for. And the only way to bring this about is to sit tight, cut out the continual agitation for higher rates of pay and higher profits, and pull together for better output, stable conditions, less luxuries and saner living. We must get back to the logical idea that wages are due for work done, and must depend on the price for which the product can be sold.

Present Gains vs. Future Losses

With coal prices soaring to unprecedented heights, cost of operation tends to seek similar levels with the result that engineers of many of the smaller plants, particularly those not required to furnish steam for heating or other purposes, find themselves in more or less of a state of quandary. To shut down and take central station service or not to shut down and await developments is the question.

The price of coal continues to advance by leaps and bounds, but not so with the rates of the majority of central stations—at least not up to the present time.

The temptation is indeed great to discard the apparently expensive isolated plant. Before doing so, however, many factors require consideration. Undoubtedly coal prices will never again return to pre-war day levels; but it is folly to presume that when once anything approaching stable conditions is reached, the existing differential between isolated plant costs and central station rates can continue. As fuel costs have increased for the isolated plant, so have they increased for the central station and while, due to state regulations, the rates of public service companies have not increased in proportion to the increase in cost of operating the isolated plant, it is obvious that eventually practically the former differential will again return. Then, other conditions remaining unchanged, that which today may appear as a loss will, when normal conditions return, in reality be a gain the same as heretofore.

New Subscription Price

It was hoped that the last Congress would see the unwisdom of taxing the education of the people of the country in their homes and places of business, and would repeal the postal law which imposes harmful and excessive zone rates on periodicals. Congress spent too much time at the last session on political maneuvers, hence did not get around to many matters concerning vitally the welfare of the country, such as postal rates, excess profits tax and department reorganization.

Consequently, a heavy increase in postage became effective on July 1, 1920. Also, during the past year there have been four increases in the cost of paper and three increases in the cost of labor for printing and binding; and expenses for editorial work, cuts, traveling and supplies have increased in proportion.

The publishers have tried to find some way to avoid increasing the cost to readers; advertisers have been called on to pay more for space and economy has been practiced wherever it would not interfere with the quality of Power Plant Engineering and its service to readers. But there seems to be no prospect of lower costs in the chief items of expense, paper and labor. On the other hand, the wages of printing workers in Chicago have just been increased about 11 per cent, and there is no course left but to ask subscribers to bear a part of the increase in expenses.

Beginning Oct. 1, 1920, the subscription price for Power Plant Engineering will be $2 a year. Present subscribers will be carried to the expiration of their subscriptions, and up to Oct. 1 may renew for one year at the old rate of $1.50. Beginning Oct. 1, all renewals and new subscriptions will be at the new rate, $2. Because of the extremely high postage rate, which averages 7 cents a copy to the Rocky Mountain and Pacific Coast states, the subscription price is 50 cents additional or $2.50 in those distant states.

We feel that readers will recognize the fairness of this course, inasmuch as the cost of producing the reading section of Power Plant Engineering is far above even the new rate asked. Improvement is the aim, and we believe that readers will prefer the better service to maintaining the lower price and cutting costs at the expense of quality. What one reader thinks is shown in the following article recently received:

Power Plant Slogans

Store Coal in Summer.
Keep and Analyze Operating Records in Every Power Plant.
Develop Water Power Sites.
Promote Health and Safety in Power Plants.
Handle Coal and Ashes Mechanically.
Employ Engineers for Engineering Work.

Bill's Fourteen Points

By Bill

1st. Power Plant Engineering is my magazine. I don't own it, but I have a lot to say. The voice of the majority rules.

2nd. This magazine goes straight to me. It appeals to my personal interest and stirs my thoughts out of the ditch of stagnation. It prompts me to self-improvement because I get to compare myself to others and their methods.

3rd. It stimulates me. For waking me up to the doings of the day, it's got hootch skinned a mile. I find no gloom in its pages.

4th. This paper is not hitched to any cause and is nobody's tool. It is progressive, always out for new ideas and it is big enough to drop the poor ideas. It has no foolish pride.

5th. This magazine is a story magazine. It is entertaining and prints things in story form. Its editorials are human and full of pep.

6th. The reading matter is edited down—that is, cleared of weeds—so that the material is not tedious and simply crowded with words instead of being packed with interest. Few articles are over two columns long.

7th. Power Plant Engineering is a good-natured paper. It prints all the fun in any article that concerns the engineer. The Editor never had dyspepsia.

8th. It is practical, and talks about things in a way I can understand without marrying a dictionary.

9th. It is fair; it encourages the man who has a problem and sets him straight. I have just as much consideration as the noted authors who help fill its pages. But the paper is bigger than any of its writers.

10th. Its advertising is dependable. The Bunco people don't try, nor could they get into its pages.

11th. This magazine rings true. I often read things that make me stop a minute and say, "Well, I know a case just like that."

12th. This paper does not foster any crank ideas, nor has it any axe to grind.

13th. I look forward to its coming because it always gives me the latest news served hot. No warmed-up stuff gets by.

14th. The guy that got me to subscribe knew what he was talking about. I'm glad I subscribed and must say it's cheap at twice the price. Take it from me, man, you'll be glad, too!

Development of Pit River Planned

A BIG STEP in the development of California's hydroelectric resources was taken Aug. 20, with the filing with the Railroad Commission, of an application by the Mt. Shasta Power Corporation, all the stock of which is owned by the Pacific Gas & Electric Co., for a certificate declaring that public convenience and necessity require the development by the company of the power project planned for the Pit River district. The installed horsepower planned aggregates approximately 515,000 and the developments would call for an expenditure of about $125,000,000, divided about equally between power plants and distribution systems.

Ideal conditions for economical water power development are furnished by the constant water supply and the rapid fall of Pit River, the company says, and it claims that "the streams of the Pit River basin can be made to deliver, ultimately, to Northern and Central California about 7,000,000 kw.-hr. a day, which is about double the capacity of all the power plants now owned and operated by the Pacific Gas & Electric Co.

It is the plan of the company, through the Mt. Shasta Power Corporation, to construct five, or more, hydroelectric power plants on Pit River. Engineers have been engaged for months planning for the immense construction task. The Pit River district has been fully surveyed, the company says, with the result that it has been determined to locate the first plants as follows:

Fall River Plant No. 1—This plant will be located on Pit River, but will be operated with water from Fall River. The intake canal will be an open cut ditch, 1130 ft. long, 26 ft. deep, with a width of 50 ft. at the bottom and 104 ft. at the top. The intake canal will connect with a concrete lined pressure tunnel, approximately 10,040 ft. long. Two steel pressure pipes 1400 ft. long and each varying in diameter from 11 ft. 3 in. at the top to 8 ft. 6 in. at the bottom, will lead to the power house and supply water to two turbines in a steel and concrete power house.

Fall River Plant No. 2—Also located on Pit River and also operated mainly with water from Fall River. Power house of steel and concrete construction will house turbine. Water will be conveyed to forebay in open ditch approximately 3 mi. long and delivered to turbine through pressure pipe 1000 ft. long and varying in diameter from 12 ft. at the top to 9 ft. at the bottom.

Pit River Plant No. 1—Site of power house on unsurveyed land. A dam 10 ft. in height will be constructed on Pit River which will form a reservoir with a capacity of approximately 50,000 acre-feet. A concrete lined pressure tunnel, 12 ft. in diameter and 4 mi. long will convey the water to a forebay from which it will be dropped to the power house by means of two steel pressure pipes, each varying in diameter from 16 ft. at the top to 12 ft. at the bottom.

Pit River Plant No. 2—Site of power house also on unsurveyed land, on Pit River, approximately 2½ mi. below Pit River Plant No. 1. A tunnel will convey the water from a reservoir made by a dam in Pit River, below Plant No. 1, to a small forebay, from which it will be dropped to the power house through a steel pipe having a diameter of 20 ft. at the top and 16 ft. at the bottom.

Big Bend Plant—A concrete-lined tunnel, approximately 7 mi. long, with an inside diameter of 20 ft., will convey the water to a forebay from which it will be dropped through steel pressure pipes varying in diameter from 11 ft. at the top to 9 ft. at the bottom to the power house, where three turbines will be installed.

The company is now engaged in securing a right of way for its transmission lines from the Pit project to a point of connection with the Drum-Cordelia power line of the Pacific Gas & Electric system. It is said that as soon as this connection is made electricity will be transmitted at 110,000 v. It is the ultimate aim of the company to extend its lines to some point on San Francisco Bay, and electricity will then be transmitted at nominally 220,000 v.

Cut in Power Consumption Ordered

A GENERAL cut of 20 per cent in the consumption of electric power, variable to individual exigencies, was decided on Aug. 15 by State Power Administractor H. G. Butler after a hearing attended by power consumers and distributers.

Agriculture and handlers of perishable goods were excepted from the decision, for the time being. The administrator said he would request all cities and towns in California to curtail street lighting, and to curtail or eliminate electric advertising signs.

Mining interests pleaded for a slighter reduction than the 15 per cent at first proposed, but they were included in the 20 per cent order. In the first stages of the hearing, one spokesman of the mines said that any curtailment would turn Grass Valley into a deserted mining camp, and pointed out that the federal government is urging all gold producers to work to capacity.

At the conclusion of the hearing, Butler prepared the formulation of an order, for immediate distribution, on the following basis:

A general reduction of 20 per cent applying to all industries and manufacturing, except those handling perishable goods.

No restrictions to be placed at present on agriculture, except that there may be no irrigation of lands from which crops have already been harvested.

No new business to be solicited by producing or reselling electric companies without permission from the administrator.

The electric companies to have the power of increasing or reducing the curtailment at their discretion in individual cases.

Manufacturers to be permitted to make the curtailment in any way they desire, by reducing the working hours per day or closing their plants for any interval, as arranged by them with the power companies.

The power companies are put in the position of policemen to enforce the administrator's rulings. The administrator no longer has the power of enforcement held by him during the war, but two weeks ago the power companies agreed to follow his rulings in the present water crisis shortage.

The hearing Aug. 18, was adjourned at the call of Butler, and probably will be followed in 10 days by a meeting to see what progress has been made.

The resale companies were chiefly represented at the session, but the chief objection came from mining interests.

According to Butler, the demand for hydroelectric power in the last few years has exceeded the supply. To keep abreast of the demand, California power companies must expend in development work $50,000,000 a year for the next 10 yr.

"Many industries," said Butler, "have abandoned their oil engines and turned to electricity because of the high cost of fuel oil and labor. With the probability that these costs never will return to pre-war levels, it seems certain that these industries will continue to use electricity.

No-Accident Week

RESULTS secured from the recent "No-Accident Week," observed by hundreds of utilities in the states of New York and Pennsylvania, during the week June 6 to 12 were indeed gratifying.

Experience in 1919 showed without a doubt that June, July and August were the bad months among public utilities, and it was wise to start as early in June as was practicable, is indicated by the fact that June started off with three fatalities in its first week. In fact, for purposes of comparison, it is of interest to note that the days lost time for the first week of June, 1920, were 22,896, with a cost of $17,998.

The two values given above are taken from records of Utilities Mutual Insurance Co., as are all statistical comparisons offered, inasmuch as that is the best available way to compare the results of "No-Accident Week" with the corresponding period of 1919.

Notwithstanding the fact that Utilities Mutual this year covers some 46 per cent more employes than it did in June, 1919, the days lost time were but one-fifth of what they were last year. This is shown by the following tabulation.

1919			1920		
Week	Days Lost Time	Cost	Week	Days Lost Time	Cost
Second	15,862	$18,362	Second*	7,752	$6,260
Third	15,490	15,319	Third	306	1,150
Fourth	8,029	4,607	Fourth	210	1,102
Total..	39,381	$38,388		8,268	$8,512

* No-accident week.

A further point of interest is that, whereas there was one fatality by electrocution during "No-Accident Week," there were none during the succeeding two weeks. During the corresponding three weeks of 1919 there were five fatalities.

It is always a distinct satisfaction to look back upon a campaign that was as successful as this one, and which proved without a shadow of a doubt that active accident prevention pays big dividends.

A STRONG belief in a gradual and natural readjustment of business conditions without financial disorder or any sudden economic calamity is expressed by the Committee on Statistics and Standards of the Chamber of Commerce of the United States, in its semi-annual bulletin on crop and general business conditions. Many present day conditions are enumerated as disturbing business factors, but in the opinion of the committee there is no need to become panicky over any of these matters.

News Notes

AT THE National Exposition of Chemical Industries in the Grand Central Palace, New York City, Sept. 20 to 24, one of the interesting exhibits will be that of the Permutit Co. Its method of softening and filtering water will be demonstrated by means of photographs, blueprints, drawings and outfits such as are carried by salesmen in the field to prove the results that can be obtained.

THE DATE for the next annual convention of the Illuminating Engineering Society (to be held in Cleveland), originally set for Sept. 27-30, has been changed to Oct. 4-7. The change was made to avoid conflict with the American Legion Convention to be held in Cleveland the last week in September. While the complete program is not yet available, it is the aim of the committee to make this convention carry a popular appeal not only to technical men, but to all those in any way interested in illumination. Attendance of men, such as jobbers, dealers, contractors, architects, educators—men who can put the better lighting idea before the public—is being solicited.

The committees in charge of arrangements is as follows: General convention committee, J. E. North, Cleveland Electric Illuminating Co., chairman; W. M. Skiff, National Lamp Works, vice-chairman; reception committee, G. E. Miller, Cleveland Illuminating Co., chairman; publicity committee, H. S. Greene, National Carbon Co., chairman; entertainment committee, J. M. Smith, Ivanhoe-Regent Works, chairman; finance committee, George S. Milner, Erner Electric Co., chairman; hotel committee, A. M. Collins, Western Electric Co., chairman; attendance committee, G. S. Black, Cleveland Engineering Society, chairman; registration committee, J. L. Wolf, Builders Exchange, chairman.

MORE THAN 1700 employes of the General Electric Co., Schenectady, have completed 25 yr. or more of service with that organization. Their combined term of service totals 47,709 yr. and their total age is 91,550 yr.

At the fourth annual outing of the General Electric Co.'s Quarter Century Club, composed of these long-service workers, which was held at Schenectady recently, G. E. Emmons, vice-president of the company in charge of manufacturing, was presented with a gold replica of the Quarter Century Club insignia in recognition of his completion of 25 yr. as manager of the Schenectady works.

Membership in the organization is divided as follows: Schenectady works and offices, 1003; district offices, 137; Pittsfield, 37; Erie, 12; Ft. Wayne, 68; Harrison, 44; Lynn, 370; Sprague and Bloomfield, 31. The average term of service represented is 29.5 yr., and the average age of the members is 54.4 yr. The oldest member is 77 yr. and the youngest 39. About a thousand members attended the outing where a clambake was held.

THE UEHLING INSTRUMENT CO., 71 Broadway, New York, manufacturer of fuel economy equipment, announces that it is now represented in the New England States by the Smith Engineering & Supply Co., 89 State St., Boston, Mass., manufacturers, agents and engineers, specializing in power plant equipment. S. W.

Smith, president of the latter company, was until recently associated with the Uehling Instrument Co., with headquarters in the New York office.

G. A. SAWIN, service engineer with the Public Service Electric Co., Newark, N. J., has resigned to become assistant to manager of the supply department, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. In his new position Mr. Sawin will take care of the public utility work of the supply department.

P. A. BOECK, manager of distribution of the Celite Products Co., 11 Broadway, New York City, is now located at the company's Los Angeles office, where he will supervise the production work. Thos. G. Lee, Jr., will act as general sales manager with headquarters in New York.

THE NARRAGANSETT ELECTRIC LIGHTING CO. of Providence, R. I., has just ordered a duplicate unit of its 45,000-kw., two element, cross compound turbine-generator. This unit will be operated at 210 lb. pressure, 125 deg. superheat and 28½ in. vacuum. The generator will be three-phase, 60-cycle, 11,000-v. To go with the generating unit, 36,000-g.p.m. twin jet condensers will be installed. These condensers will be steam turbine and gear driven. The installation is interesting because the unit now installed is the largest generating unit in the world which is equipped with jet condensers. It will be remembered that the 45,000-kw. unit now installed at this station recently completed what is thought to be the world's record for a continuous run of large triple expansion cross-compound turbine-generators, having operated 84 days without being shut down.

Trade News

THE OXWELD ACETYLENE CO. has established Pacific Coast sales and distributing headquarters at San Francisco, with offices at 1077 Mission St. Leo Romney, with headquarters at San Francisco, is Pacific sales manager. The territory embraces the states of Washington, Oregon, Idaho, Utah, Arizona, California, Nevada and the counties of Lincoln, Sweetwater and Uintah in Wyoming. This territory was formerly served from Chicago and Los Angeles.

The company's export department, which was formerly located at its factory in Newark, N. J., has been removed to the Carbide and Carbon Building, 30 East Forty-second St., New York. The department has been reorganized and is now under the direction of R. G. Noble, who will co-operate with the general sales department of the company.

THE MONO CORPORATION of American announces the removal of its main office from Buffalo, N. Y., to 25 West Broadway, New York City, where their complete line of automatic continuously recording gas analyzing instruments for CO_2, CO, O_2, SO_2, H_2, N_2, CH_4, etc., will be displayed. F. D. Harger, vice-president and general manager, assisted by D. W. Reid and other chemical engineers and combustion experts, offer consulting service in matters relating to the automatic, continuous recording of gas analyses in the scientific control of combustion and chemical processes.

UEHLING INSTRUMENT CO., 71 Broadway, New York, has just issued Bulletin No. 111, describing Style U Uehling CO_2 equipment.

A NEW FOLDER, C-805, descriptive of Yarway pipe-joint and Yarway Holtite pipe clamps has been received from Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa. The company will gladly furnish copies of these folders to those interested.

MUCH of the difficulty and all the mystery is dispelled from the buying of cotton waste by a perusal of the little book, "Clean, Clean Thru," published by the Royal Manufacturing Co., Rahway, N. J. While by no means technical, the book gives a "close-up" of cotton waste manufacture all the way from raw material to the finished article.

A MOST instructive bulletin, No. 41,311, superseding Bulletin No. 4859, from the press of the General Electric Co., covers the subject both of power-factor correction and more recently power-factor control through synchronous condensers. Particularly interesting sections of the bulletin are the data on power-factor, causes and effects of low power-factor, and the application of the synchronous condenser, with several calculations of such installations both for power-factor correction and control.

THE KELLY high-pressure controller, a safety device serving as a non-return valve, positive stop valve, alarm and steam separator is discussed in a booklet lately received.

Another new booklet describes the Kelly low-pressure controller, whose object is to prevent cracked sections, explosions and shut-downs.

Copies of either or both catalogs will be sent to any interested reader on application to the Kelly Controller Co., 175 W. Jackson Blvd., Chicago.

THE NEW instruction book put out recently by the Oxweld Acetylene Co., Chicago, Ill., is one of the best treatises on every-day oxy-acetylene welding and cutting that has thus far been produced in the commercial literature of the industry. The little volume is a compact and handy brochure, containing 55 printed pages, inclusive of illustrations and drawings. It covers the field of everyday applications in a clear and concise treatment and in language that is easy for the beginner to grasp, and it is at the time invaluable to the experienced welder and cutter.

"BEARINGS AND Their Lubrication" is the title of a 32-page educational booklet recently issued by the Vacuum Oil Co., New York. It was prepared by their technical department and covers the construction of bearings and methods of lubrication as well as the properties of oils and greases in a thorough manner. The descriptive matter is accompanied by numerous illustrations and the method of showing many of the diagrams in two colors simplifies their use. Bearing troubles are discussed in detail and remedies for overheated bearings suggested. The publication is clearly written and is intended to serve as a reference book as well as a text book in colleges and for those whose work requires a knowledge of lubricating problems.